Hurricane Bret Post-Storm Assessment: A Review of the Utilization of Hurricane Evacuation Studies and Information Dissemination

Governor's Division of Emergency Management

Hazard Reduction & Recovery Center

Texas A&M University
College of Architecture

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Hurricane Bret
Post-Storm Assessment:
A Review of the Utilization of Hurricane Evacuation Studies and Information Dissemination

Prepared for
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and
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Executive Summary

Hurricane Bret came onshore in Kenedy County, Texas on the evening of August 22nd, 1999. Although the storm was at one point a Category 4 hurricane, its impact was minimal, because the storm decreased in strength before landfall and it made landfall at a thinly populated section of the coast. No fatalities were directly attributed to the storm, and direct damages were estimated at about 60 million dollars.

This report was undertaken by the Hazard Reduction and Recovery Center of Texas A&M University under contract to the Governor's Division of Emergency Management of the State of Texas and FEMA in order to study the accuracy and effectiveness of hurricane planning and studies completed prior to the event. In order to do so, interviews were conducted with local emergency managers, elected officials, State agency personnel, and member of the media in 12 counties along the Texas coast. In addition, a mail survey of a random sample of residents in the most affected areas was undertaken. The results of this study show that problems with evacuation, while localized, were serious enough to merit further attention. Evacuation participation rates were low for the most part, but the barrier islands evacuated almost completely.

The following recommendations resulted from this study:

Chapter 3

- **Media**

3.1. Make sure all media outlets understand the policies on hurricane evacuation shelters, and have the necessary information to pass on to the public.

3.2. The media outlets we interviewed do not have accurate information on the circumstances under which I-37 will be reversed. They are thus not able to accurately inform the public on this important policy. DPS needs to make sure they have contacted all mass media outlets in the Corpus Christi area to explain the constraints on I-37 reversal, so the public does not expect automatic reversal in the case of any hurricane's approach.

3.3. EOCs should speak with a unified voice. A public information officer should be available to answer all questions from the media, so as to avoid the confusion of contradictory messages going out to the media.

3.4. In areas with numerous media outlets, some effort should be made to distinguish between the message from emergency management and the opinions of media personalities. The latter can vary, and it is not possible to require them

all to say the same thing. They should, however, make an effort to coordinate their messages so as to avoid unnecessary confusion among the public.

3.5. Information coming from official sources should be couched in non-technical language, so as to minimize the need for interpretation by the media, which can allow errors to creep into the message.

3.6. Official sources should establish contact with the media as early as possible in an event, so as to minimize the amount of time the public does not know what emergency management officials are doing and advising.

3.7. As much as possible, media outlets should be encouraged to provide all viewing/listening areas with information specific to their needs. This would help local emergency management officials of the smaller communities surrounding large media markets to distinguish between their recommendations and those of the larger city emergency managers.

3.8. Because of the demographics of the impact area, a serious effort must be made by state and local elected officials and emergency management officials to cultivate a working relationship with Spanish-language television and radio stations, in order to ensure that they have the most accurate and timely information possible.

3.9. Media outlets could capitalize on public interest in hurricanes to gain market share by billing themselves as the place to get accurate information in an emergency. This is an opportunity for cooperation between DEM and commercial media outlets.

• **Shelter Management**

3.10. Private entities such as nursing homes should be informed of the state requirement that they plan for relocation of their patients in case of an evacuation, and a review process should be developed to ensure that they have emergency plans that are current, frequently reviewed, updated, and exercised.

3.11. The Red Cross needs to publicize its policy on providing shelter in coastal counties, and explain the logic of its position. This will hopefully encourage people to take an emergency seriously and more likely to evacuate. A reevaluation of its shelter policy is recommended in light of the varying potential for surge-related flooding along the Texas coast.

3.12. Lists of items required by evacuees should emphasize bedding and prescription medications, because shelter providers frequently mentioned that evacuees did not bring these.

3.13. Shelter locations must be communicated accurately. Reliance on coded lists, in which the number of a facility on the list of shelter locations was not related to the order in which it was opened, caused unnecessary confusion.

3.14. Smaller communities along evacuation routes should be included in shelter planning.

3.15. Plans need to be made to cover the requirements of special needs populations in case of emergencies. Such plans may involve local churches, hospitals, or other organizations, as well as, or instead of the Red Cross.

3.16. Evacuating jurisdictions should ensure that communities along their evacuation routes are advised when they issue evacuation requests. This could be accomplished by sending the evacuation requests to the DDC and the state EOC, who could then include it with other pertinent information on TLETS and other outlets.

3.17. A serious effort should be made to find shelters with air conditioning, especially for the use of the elderly and infants who are more vulnerable to the effects of heat exhaustion.

3.18. The state shelter assessment program should be expanded to include communities inside risk zones in order to support local efforts to provide adequate shelters in areas not threatened by storm surge.

- **Traffic Management**

3.19. Educate the media and the public on the specific conditions under which southbound lanes on I-37 will be reversed. Mount a public awareness campaign using all available channels of communication to deliver a unified message about the reversal.

3.20. Opening of different agencies' EOCs should be coordinated, since they rely on each other for support during hurricane operations.

3.21. Political decision-makers and technical personnel must work together on evacuation decisions in major population centers such as Corpus Christi. Decisions should not be reached in isolation from agencies charged with their implementation, and should not be announced in the absence of agreement among all the principals.

3.22. Mount a public education campaign to increase awareness of alternate evacuation routes and destinations.

3.23. Increase the number of evacuation roadway network signs on all routes to aid in public awareness, both of the need to plan for evacuation and of the variety of possible routes available to them.

3.24. Work with local radio stations to improve reporting on traffic conditions during evacuations.

- **Prison Evacuations**

3.25. Develop an evacuation plan for each TDCJ Region. The development of these plans should include both the evacuating units and the host units.

3.26. Provisions must be made for using TDCJ personnel to escort evacuation buses, because the DPS does not have enough people to cover both civilian and inmate needs.

3.27. Decentralize evacuation decision making as much as possible, including the administrators of individual prisons because they are most familiar with the populations in their care and the potential problems of an evacuation. An effort should be made to make these decisions early enough to allow most prisoners to be moved before the civilian population evacuates.

3.28. TDCJ should coordinate its operations with other agencies. This can be facilitated by such measures as maintaining a presence in key local EOCs during an event, and by reviewing TDCJ evacuation plans with local emergency managers and DPS.

3.29. Policies on wind tipping speeds of TDCJ buses should be updated based on the best technical advice available.

• Emergency Management

3.30. Emergency Management Directors must have some training in emergency management.

3.31. A study should be made of the feasibility of mandatory evacuation in Texas. The study should be performed in an open, inclusive manner so that the pros and cons of such a policy can be debated and consensus can be reached. In the absence of mandatory evacuation, guidelines should be developed that can help raise the likelihood of evacuation from Risk Areas where it is recommended.

3.32. Currently, there is one Regional Liaison Officer for a large area of South Texas, extending from San Antonio to Brownsville. This territory is too large and varied to be adequately covered by one person. Consideration should be given to splitting this territory between two or three Regional Liaison Officers.

3.33. The number of traffic counters on evacuation routes should be increased. This should be done as soon as possible, to build up a database of typical traffic on evacuation routes for the purposes of comparison with traffic during an evacuation. This will help emergency managers have a better idea of how many people are actually evacuating, when they start to leave, how slow traffic moves, and other information that is not currently available.

3.34. If possible, some means should be found for FEMA's information on hurricane damages to be shared with local emergency management coordinators to help them better prepare their jurisdictions for hurricanes, while at the same time protecting the privacy of those requesting aid. One possibility would be giving local emergency managers information on number of requests made by people living in each zip code. Moreover, household averages, by zip code, might be feasible.

3.35. DDCs must ensure that at least a two-person crew of telephone operators is always available during activation of the EOC, and that local emergency managers, county sheriffs, police departments, fire departments, mayor's offices, county judge's offices and all other agencies have the correct telephone numbers for use during an activation.

3.36. Consideration should be given to finding an alternative to TLETS that can be geared specifically to emergency management. TLETS carries many messages not of value to emergency management, which can increase confusion during an event. In some cases, the local emergency management offices are not conveniently close to the DPS location that has TLETS. In such cases, some communications link should be established by the DPS and local emergency manager. Such an emergency management network could be run over the Internet, since most local emergency managers have web access or could get it fairly easily.

3.37. The possibility of renaming the Study Areas should be considered. The purpose of this step would be to address some of the concerns of the smaller jurisdictions. For example, the area currently known as the Corpus Christi Study Area could be called the Coastal Bend Study Area, and the area currently known as the Brownsville Study Area could be called the Lower Valley Study Area.

3.38. The cities that border Mexico need to study the issues that could arise during a hurricane and develop joint emergency management plans with their cross-border neighbors. They should be assisted in this effort in any way possible.

3.39. County Judges and other political officials should take care to issue signed evacuation requests that give precise directions on which areas of their jurisdictions are being asked to evacuate. This may help increase compliance with evacuation requests.

3.40. It would be helpful to have Forecast Advisory updates from NHC at more frequent intervals. This would encourage local officials to think ahead about what responses might be needed if there are sudden changes in a storm's characteristics, such as those that occurred when Hurricane Bret changed from a Category 2 to a Category 4 storm between two updates.

3.41. Improvements to the information systems at DEM should continue. Much of the data needed for decision making could be automatically downloaded from the web to a server, and accessed by anyone who needed it. All output from DEM hurricane programs could also be made available on the web, which would simplify access by local emergency managers. DEM staff should include more specialists in information technology to adequately address these issues.

3.42. No single decision support program provides a complete picture of the situation. Therefore, it is recommended that the state and local communities further develop their capabilities in the use of several systems such as Hurrevac.

Chapter 4

• Assessments of HES Products

4.1. Redesign ESTED and DERC to be more user-friendly. The most important thing is to provide a graphical user interface, which will make it much easier to get around the program and get what is needed out of it. As part of this redesign, all calculations and algorithms should be checked for accuracy.

4.2. The process of putting all HES products on the web should be continued. This will make them easier to update, and easier to search quickly for needed information.

4.3. Make all public information available in Spanish, both on the web and in paper copies.

4.4. Put the Risk Area maps, including evacuation routes and survival tips, on the DEM website for easy public access.

4.5. Continue to supply paper copies of the Risk Area maps, with evacuation routes more clearly marked and updated survival tips. Not all households have internet access, and those that do may lose that access in a hurricane. Encourage local emergency managers to make these documents readily available to their citizens.

4.6. Improve the capabilities of DERC to include information on the type of land use that will be affected by a hurricane. This would be possible to do quickly from a GIS system. Such a system would also be useful to improve the analytic capabilities of ESTED.

4.7. Review all clearance times given by ESTED, to make sure they incorporate current road conditions, population levels, surge data and findings from the behavioral survey.

Chapter 5

• Evacuation Behavior

5.1. Local governments located on the barrier islands should continue their policies of encouraging total evacuation. They should be supported in these efforts by DEM.

5.2. Public information efforts have not yet reached the entire population, as indicated by the percent of respondents who said they had received information on hurricanes. DEM and local emergency managers should continue to distribute information at all possible opportunities. Spanish-language materials should be used where necessary. The possibility of forming partnerships with local businesses should be studied as a means to disseminate information.

5.3. Corpus Christi officials should continue to study the unique evacuation problems they face. The unfortunate side effect of a near miss like Bret could be to desensitize the population to the potential for danger. DEM should consult with Corpus Christi on evacuation clearance times, which may need to be readjusted to reflect changing settlement patterns, and local officials should be alert to the fact that an evacuation request needs to be issued well before predicted landfall in order to minimize traffic congestion.

5.4. Alternate evacuation routes should be well-publicized and marked at each major intersection. Traffic management authorities should monitor the progress of the evacuation and provide the news media with information on alternate routes that are less congested.

5.5. Specific populations or individuals may need alternate means of transportation in order to evacuate. Local emergency managers should examine their communities for such groups or individuals and try to ensure everyone who wants to leave can do so. Private hospitals and nursing homes should be required to demonstrate the viability of their evacuation plans to local emergency managers. DEM and other state agencies should be encouraged to take the lead in developing transportation programs for special needs populations.

Chapter 1 Introduction

• Background

On August 18, 1999, a tropical depression formed in the Bay of Campeche. By the next day, the disturbance became Tropical Storm Bret. This storm intensified over the following days, and by Saturday August 21st it was a category 4 hurricane approaching the Texas coast.

The first storm tracks predicted a landfall in northern Mexico. Then the storm headed north and appeared to threaten the Corpus Christi area. Voluntary evacuation of Padre and Mustang islands began on Saturday afternoon, and an estimated 180,000 people left the coast and headed inland (NWS Preliminary Storm Report, September 1, 1999). During the morning and afternoon hours of Sunday the 22nd, Bret veered to the west, finally making landfall at about 7 p.m. in central Kenedy County. This is one of the most sparsely populated counties in Texas, so the state was spared the potentially severe consequences of other possible tracks. Bret produced heavy rains as it moved across south Texas during the night of the 22nd and the 23rd, finally entering Mexico as a tropical depression on the evening of the 23rd.

• Purpose of PSA

This Post-Storm Assessment was conducted by the Hazard Reduction and Recovery Center (HRRC) of Texas A&M University under contract to the Governor's Division of Emergency Management of the State of Texas. The Hazard Analysis Laboratory located in the HRRC has produced a number of Hurricane Evacuation Study (HES) documents and decision aids for the use of local governments and emergency professionals. These products include the computer programs ESTED and DERC, storm atlases and contingency guides for each of the five Study Areas on the Texas coast, and public information materials for distribution by local officials. The purpose of this report is to evaluate the use of these materials during Hurricane Bret. The main questions were: how much did emergency management officials use each of the HES documents and products, and how could they be improved?

• Methods of PSA

This report is based on several data sources. First, the HRRC conducted a series of interviews with local emergency managers, elected and appointed officials, police and fire departments, DPS officers, Red Cross shelter managers, and other individuals. These structured interviews focused on the decisions made during the hurricane and the use of

HES items as aids to decision-making. A list of individuals interviewed is included in the appendix.

A second source of data for this report is a mail survey of households in the five counties most directly affected by the Hurricane: Nueces, Kleberg, Kenedy, Willacy and Cameron. A random sample of households was chosen from each of these counties and questionnaires were mailed to them. The survey asked about the behavior of households during the hurricane and their losses due to the hurricane. A copy of the questionnaire is included in the appendix.

Finally, documents were gathered for content analysis. These documents include after-action reports from special facilities, damage assessments, traffic plans, public information materials, and others. A list of documents used in this report is included in the appendix.

- **Overview of PSA**

The next chapter, the Hazard and Vulnerability analysis, will describe the storm in more technical terms. This chapter will also discuss the possible impacts of alternative storm scenarios, and the impacts of Hurricane Bret on the infrastructure and economy of the state.

Chapter 3 will provide the results from the interviews and the documentary content analysis. Chapter 4 will offer a critique of existing HES products and identify improvements that could be made, and Chapter 5 will discuss findings from the mail survey.

Chapter 2 Hurricane Bret

- **Potential for Damage**

Much of the Texas coastline has a very shallow slope, which makes it extremely vulnerable to damage from hurricanes. There is a high potential for damage from winds as well as from storm surge and flooding due to rain.

The south Texas coastal population is concentrated in several urban areas, with sparsely populated regions between them. Hurricane Bret made landfall in the most sparsely settled coastal county, sparing Corpus Christi and Brownsville. [By the time Bret came onshore, winds had died down to 125 mph from their peak of 140 mph.]

For hurricane planning purposes, the Texas coast is divided into five Risk Areas, with 1 being the closest to the Gulf and the most vulnerable. Table 2.1 shows the distribution of population by Risk Area in the five counties most affected by Hurricane Bret. This table shows that a landfall in Kenedy county is exactly that least likely to cause serious wind and surge-related damage to residential, industrial and commercial property.

Risk Area	Nueces	Kleberg	Kenedy	Willacy	Cameron	Total Population by Risk Area
1	20769	162	2	524	12816	34273
2	16930	89	1	27	243	17290
3	251335	606	61	265	9180	261447
4	13541	560	31	1170	46248	61550
5	14774	26519	30	15960	216374	273657
Total Population in Risk Areas	284861	28150	137	15225	317349	645722
Total Population in County	315469	30274	460	17705	329131	693039
% Pop. in Risk Areas	90.29	92.98	29.78	85.99	96.42	93.17

Table 2.1: Population Distribution by Risk Area

There was a great deal of uncertainty in the NHC forecasts for Hurricane Bret due to weak steering currents in the upper atmosphere. It was designated a named storm in the 5 p.m. advisory of September 19th, and developed hurricane force winds about 24 hours later. Models run over the next hours gave varying results, but by the morning of Saturday the 21st hurricane warnings were recommended for the coast from La Pesca, Mexico to Baffin Bay, Texas. At 10 pm that evening, the NHC hurricane warnings were extended to Port O'Connor. By the morning of Sunday the 22nd, the hurricane had begun its westward turn, and it continued to track west. The eye made landfall in central Kenedy County, 20 miles north of Port Mansfield, at about 5:45 on Sunday evening.

For some time on Saturday August 21 and into the morning of the 22rd it seemed that Bret was heading for Corpus Christi. Such a path would have more serious consequences for the state than the actual storm track. Figure 2.1, the Average Forecast Error, shows that there was a substantial amount of uncertainty about the hurricane's path as late as 4 pm on Sunday. This is not an unusual amount of uncertainty. The average forecast track errors for Hurricane Bret were 65 nautical miles at 24 hours out, 155 nautical miles at 48 hours out, and 255 nautical miles at 72 hours out. These values are actually below the average for the past ten years (Lawrence and Kimberlain 1999). However, this level of uncertainty is still a problem for local evacuation decision making.

- **Hurricane Bret Data**

The actual track taken by Hurricane Bret is shown in Figures 2.2 and 2.3. These figures show the wind swath forecast at 17:00 EDT (4 pm CDT) on Sunday the 22nd, just before landfall, and at 05:00 EDT (4 am CDT) on Monday the 23rd, after landfall. These figures show how the wind swath narrowed as it moved inland.

By the time of landfall, winds were slowing in speed. Figure 2.4 shows a model of the maximum envelope of wind at 4 pm CDT. The model predicted winds of up to 109 mph in the coastal counties. Reported sustained windspeeds shown in Table 2.2 did not exceed 72.04, with gusts reported as high as 97.75 mph (National Weather Service 1999, Lawrence and Kimberlain 1999).

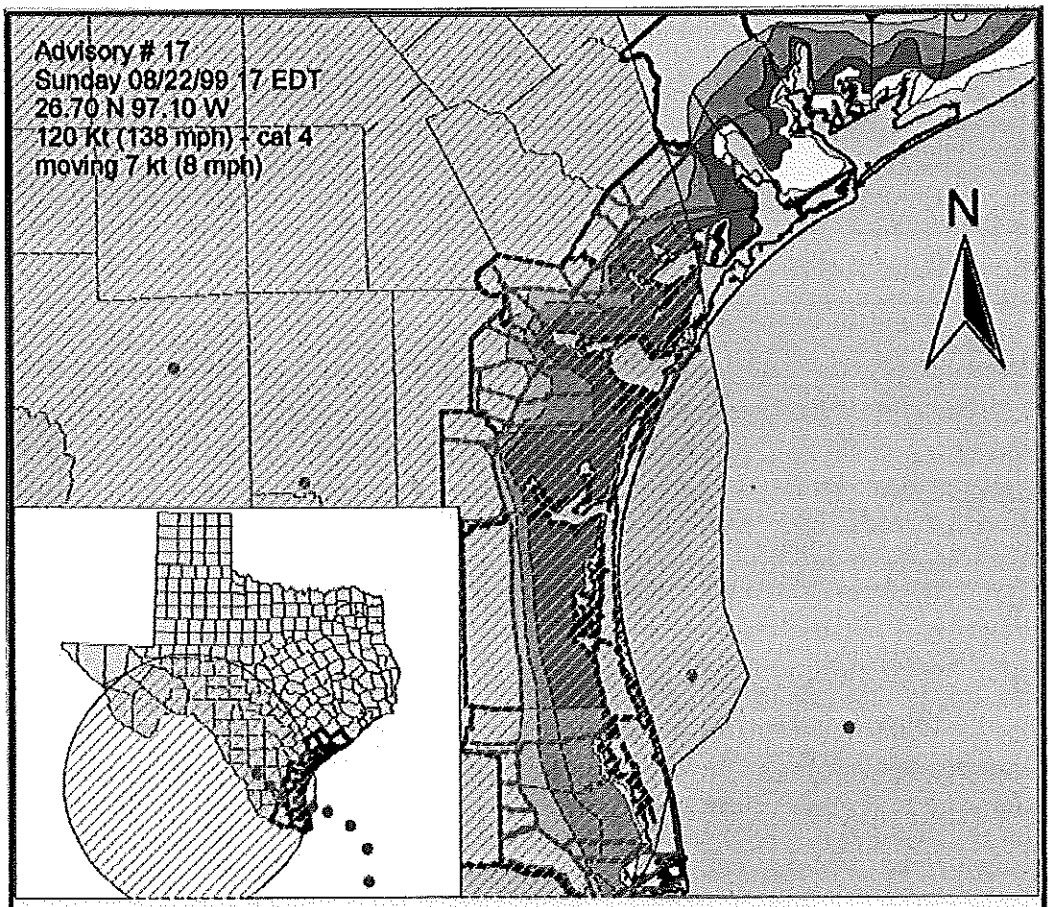

Figure 2.1
AVERAGE FORECAST ERROR
HURRICANE BRET - ADVISORY # 17

Legend

- Risk area 1
- Risk area 2
- Risk area 3
- Risk area 4
- Risk area 5
- Hurricane track
- Evacuation routes
- Coastal counties
- Non coastal counties
- Wind swath

The eye should track within the wind swath in the next 72 hours.

Source: Hurrevac 2000
Based on forecasts from the National Hurricane Center (NHC), Central Pacific Hurricane Center (CPHC), and the Hydro-met Prediction Center (HPC)

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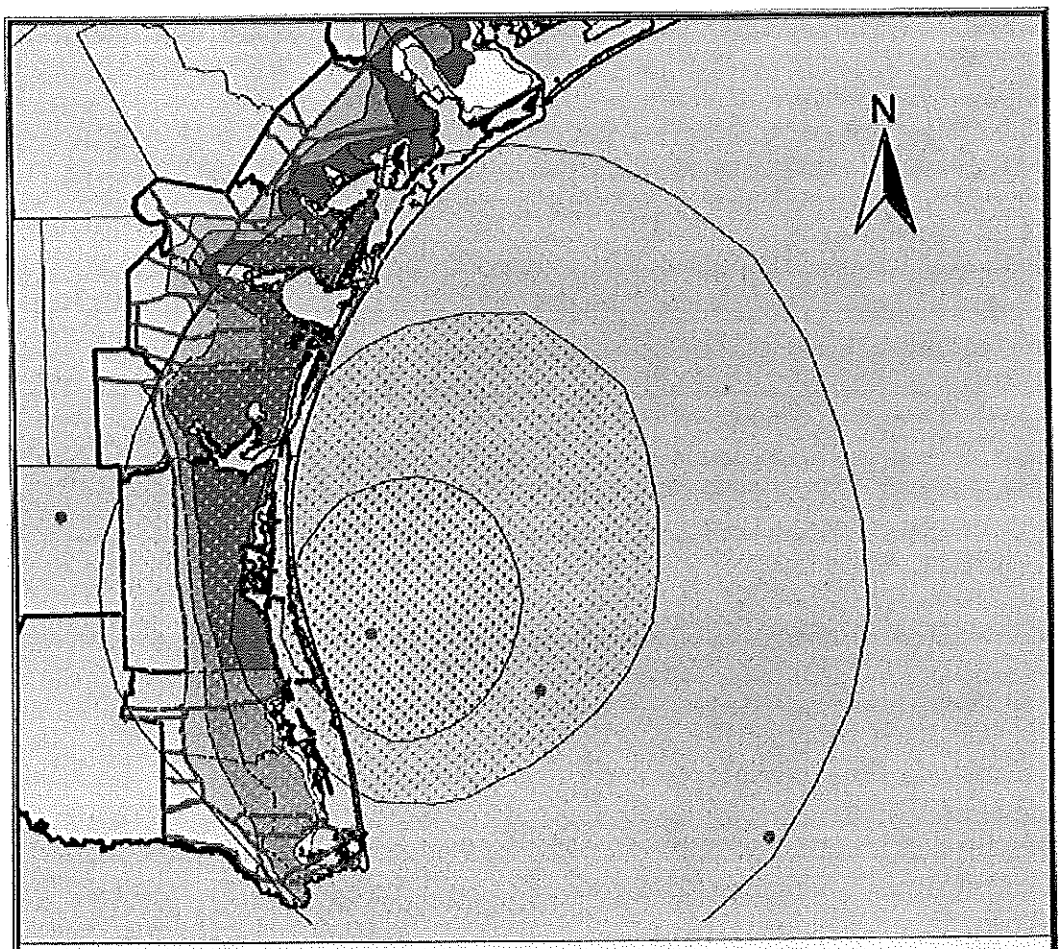

Figure 2.2
FORECAST WIND SWATH
HURRICANE BRET - ADVISORY # 17

Legend
> 34 kt (39 mph)
> 50 kt (58 mph)
> 64 kt (74 mph)
Hurricane track
Evacuation routes

Risk area 1
Risk area 2
Risk area 3
Risk area 4
Risk area 5
Coastal counties
Non coastal counties

Advisory # 17
Sunday 08/22/99 17 EDT
26.70 N 97.10 W
120 Kt (138 mph) - cat 4
moving 7 kt (8 mph)

Source: Hurrevac 2000
Based on forecasts from the National Hurricane Center (NHC),
Central Pacific Hurricane Center (CPHC),
and the Hydro-met Prediction Center (HPC)

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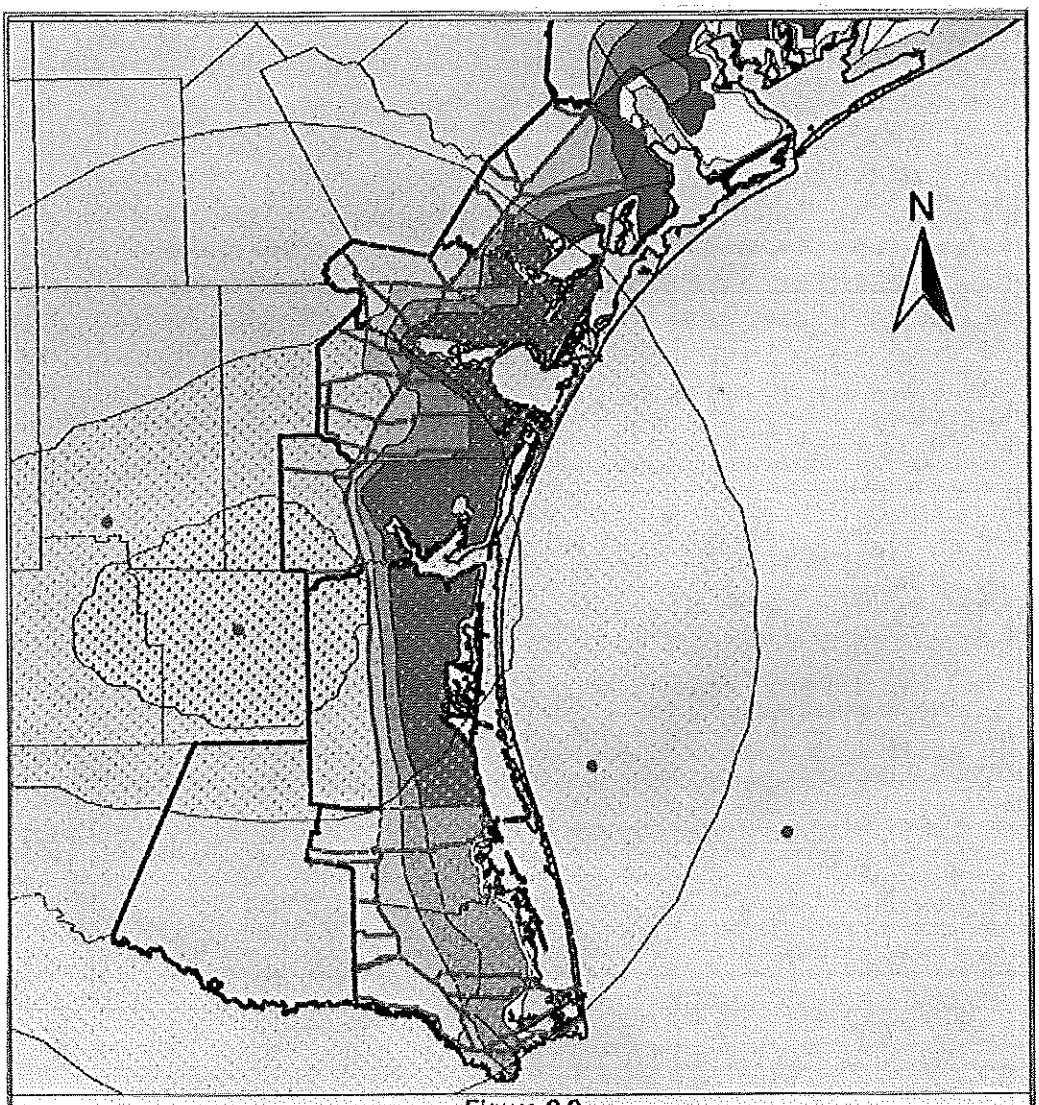

Figure 2.3
FORECAST WIND SWATH
HURRICANE BRET - ADVISORY # 19

Legend
> 34 kt (39 mph)
> 50 kt (58 mph)
> 64 kt (74 mph)
Hurricane track
Evacuation routes

Risk area 1
Risk area 2
Risk area 3
Risk area 4

Risk area 5
Coastal counties
Non coastal counties

Advisory # 19
Monday 08/23/99 05 EDT
27.10 N 98.20 W
75 Kt (86 mph) - cat 1
moving 5 kt (6 mph)

Source: Hurrevac 2000
Based on forecasts from the National Hurricane Center (NHC),
Central Pacific Hurricane Center (CPHC),
and the Hydro-met Prediction Center (HPC)

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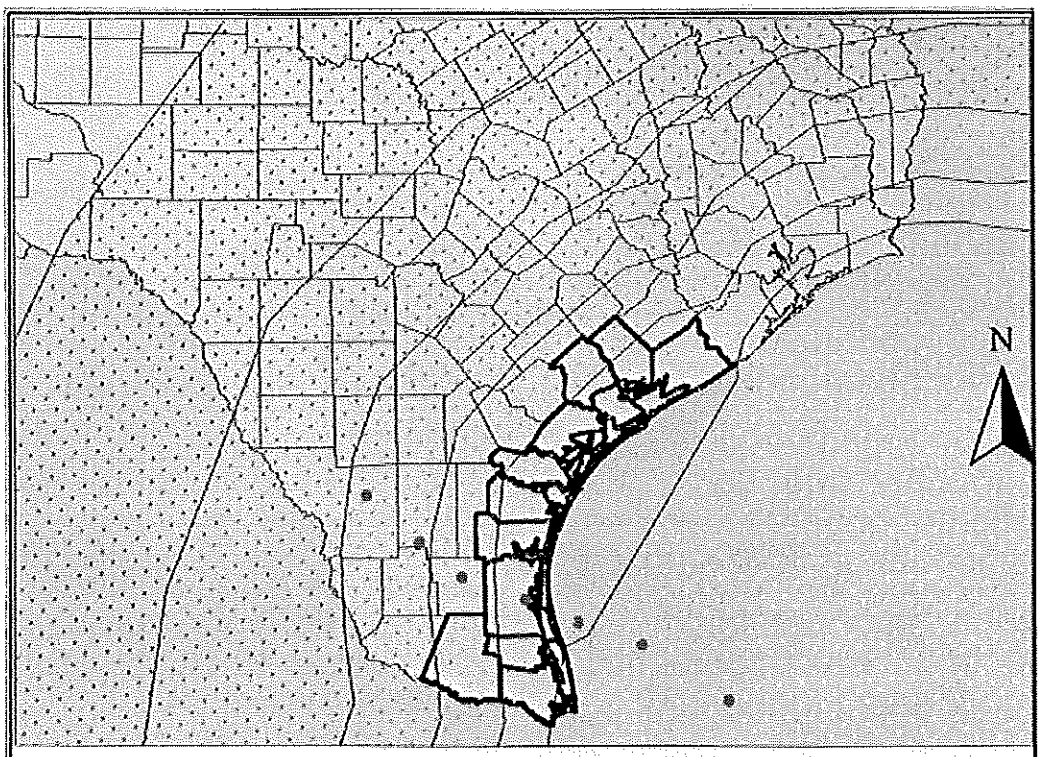

Figure 2. 4
DECAY MODEL MAX ENVELOPE OF WIND
HURRICANE BRET - ADVISORY # 17

Legend

- > 54 kt (39 mph)
- > 50 kt (58 mph)
- > 64 kt (74 mph)
- > 80 kt (92 mph)
- > 95 kt (109 mph)
- > 110 kt (127 mph)
- Bret track
- Coastal counties
- Non coastal counties

Decay model MEOW
Gulf coast approach

Max wind 125 kt (144 mph)
forward speed 12 kt (14 mph)

Advisory # 17
Sunday 08/22/99 17 EDT
26.70 N 97.10 W

Source: Hurrevac 2000
Based on forecasts from the National Hurricane Center (NHC), Central Pacific Hurricane Center (CPHC), and the Hydro-met Prediction Center (HPC)

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Location	Sustained Wind	Peak Gust	CDT-Date
Corpus Christi	44.85 mph	55.20 mph	0:50 8/23
Rockport	39.10 mph	47.15 mph	10:06 8/23
Victoria	25.30 mph	32.2 mph	13:10 8/24
Alice	44.85 mph	55.20 mph	12:47 8/23
Cotulla	37.95 mph	46.00 mph	15:26 8/23
Kingsville	40.25 mph	50.60 mph	13:44 8/22
Mcmullen	----------	43.7 mph	16:24 8/22
Port Aransas	47.15 mph	----------	----------
Aransas Pass	----------	65.55 mph	16:15 8/23
Brownsville	33.35 mph	54.05 mph	18:30 8/22
Cameron City	41.40 mph	52.90 mph	18:41 8/22
Harlingen	43.70 mph	55.20 mph	22:08 8/22
McAllen	32.20 mph	42.55 mph	22:09 8/22
South Padre Island	43.70 mph	55.20 mph	19:15 8/22
Arroyo Colorado	49.45 mph	65.55 mph	19:00 8/22
Port Mansfield	48.30 mph	75.90 mph	22:00 8/22
Rincon del San José	72.04 mph	89.70 mph	22:30 8/22
Falfurrias	----------	97.75 mph	03:30 8/23

Table 2.2: Highest Winds

Three tornadoes were reported, in Aransas. Kleberg, and Jim Wells counties. No fatalities or injuries were reported, and the reported damage was minor. No significant coastal flooding was reported, but there was some river flooding along the Nueces and Aransas rivers and Oso Creek, and widespread flash flooding was reported across south Texas. Rainfall totals for the five-day period from Saturday August 21 through Wednesday August 25 are shown in Figure 2.5. The only reported storm surge was 1.1 feet at Port Isabel in south Texas (Lawrence and Kimberlain 1999). The lack of surge data may be due to the lack of data collecting stations along the section of the coast most affected by the storm.

- **Hurricane Bret Impacts**

Bret's eye passed over Padre Island National Seashore, and about 12 new channel cuts were visible in satellite images. There was also some beach erosion, reduction of dune height and formation of new dunes on the barrier islands (NWS 1999).

Damage estimates are shown in Table 2.3. These figures are from the National Weather Service and from local government reports. The National Hurricane Center reported insurance damage claims of 30 million dollars, which multiplied by 2 gives an estimate of 60 million dollars in direct damages (Lawrence and Kimberlain 1999).

Hurricane Bret damaged the cotton crop, which was in the middle of being harvested at the time of impact. Kenedy County extension agents estimated losses to the cotton farmers of at least 18.5 million. These losses were also expected to negatively affect other county businesses, with an estimated total impact of $53.64 million (Corpus Christi Caller-Times, Saturday August 28, 1999).

Location	Item	Damage
Alice		$50,000
Brownsville		$188,000
Corpus Christi	Homes & Businesses Total Damages Naval Air Station	$4-500,000 $1,000,000 $1,000,000
Port Aransas		$13,636
Aransas County		
Brooks County		$10,000
Cameron County	Property, Infrastructure, Debris removal	$1,145,704
Duval County	Property Land	$1,000,000 $750,000
Kleberg County	Property Crops	$100,000 $250,000
San Patricio County	Property, Infrastructure, Debris removal	$195,000

Table 2.3: Damage estimates

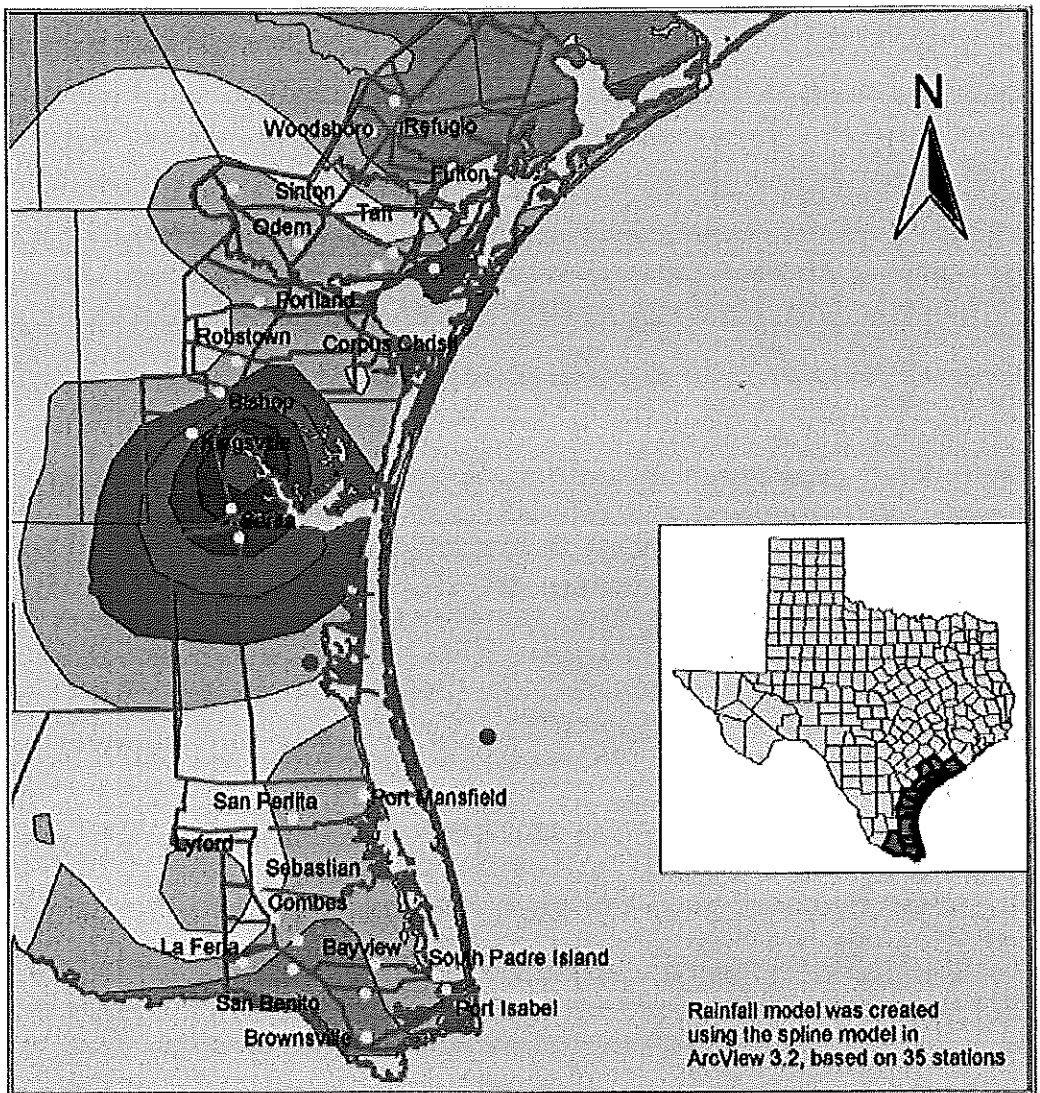

Figure 2.5
RAINFALL ESTIMATION HURRICANE BRET
August 21 - 25, 1999

Legend

Cities
Hurricane track
Evacuation routes
County boundary

Rainfall (inches)

0 - 2
2 - 4
4 - 6
6 - 8
8 - 10
10 - 12
12 - 14
14 - 16

Source: Climatological data Texas
August 1999
National Oceanic and
Atmospheric Administration

Hazard Analysis Laboratory
Hazard Reduction and Recovery Center
Texas A&M University

Chapter 3 Official Decision Making and Actions During Hurricane Bret

This chapter is based on information from a series of interviews of over 64 local officials, state agency personnel, and non-governmental organization personnel in 12 counties and numerous jurisdictions by HRRC personnel during June and July 2000. Interviews were done in the following counties: Victoria, Calhoun, Refugio, Bee, Aransas, San Patricio, Nueces, Kleberg, Kenedy, Willacy, Cameron, and Hidalgo.

- **Media**

Most media outlets began hurricane coverage on Saturday morning, and continued through Monday evening. Coverage was most intense from Saturday evening through Monday evening. Television stations vary in their capacities, with some having a staff of full-time meteorologists while others have only newscasters or weather reporters. The amount of coverage given to the hurricane varied with the stations' capacities. Some had continuous reporting for several hours, others relied on hourly updates and crawl messages to inform their viewers.

There are no news radio stations in the impact area, but some of the TV stations also control radio stations. Many stations have traffic condition capacity, and were able to use this as a tool to update evacuees on the road. For the most part, however, radio coverage of road conditions and hurricane information in general was limited by the lack of a full-time news radio station in the impact area.

Media personnel cited several sources of information. There was general agreement that the National Weather Service bureaus in Brownsville and Corpus Christi were very helpful, giving the most accurate and timely information possible. TXDOT's 1-800 number was also a useful source of information for the media. TX-DOT was also cited as a good source of faxed information on road closures. Contact with DPS was variable; some informants said it was very good, but others had had no contact with DPS.

There was a media presence in the state EOC, but this did not necessarily translate into accurate and timely information on the radio, because stations have a great deal of discretion in what and how to use this source. Most, but not all, outlets had received some public information materials from DEM. More will be said on this issue in Chapter 4.

Communications with the local officials were more problematic. Some outlets have enough personnel to station someone in the local EOC full time, while others do not and

were not always notified of the timing of press conferences, which compromised their ability to inform their viewers. There were reports of conflicting information coming from different sources in local EOCs, and informants felt that was confusing for them and the public as well. Most stations reported participating in drills or exercises with local emergency management and officials.

Information on shelter locations was difficult to come by, in most cases. The Red Cross now has a policy of not opening shelters in coastal counties, in order to encourage evacuation and to keep their volunteers out of harm's way. This policy has not been clearly explained to media outlets, however, and the public is thus not well informed on the issue. There were shelters of last resort open in some cases, but there was little information available on their locations.

A particular problem is the lack of linkages between the Spanish-language television stations and local and state level emergency management. While all English-language sources had received copies of local hurricane plans, none of the Spanish-language stations had received them. In some cases, this problem has been addressed, and efforts by both the media and the local government have led to improved working relations since Bret.

Some of the emergency management and local officials from areas surrounding the major media markets of the impact area expressed some frustration with the lack of information specific to their needs. Although they are a small percentage of the region's population, they believe the media has a responsibility to inform their citizens as well as those in larger jurisdictions.

There was little communication with FEMA, and some interviewees expressed a desire for more contact with FEMA, so they could do a better job of explaining federal policy and procedures to their customers.

Based on this series of interviews, the following recommendations are made:

3.1. Make sure all media outlets understand the policies on shelters, and have the necessary information to pass on to the public.

3.2. The media outlets we interviewed do not have accurate information on the circumstances under which I-37 will be reversed. They are thus not able to accurately inform the public on this important policy. DPS needs to make sure they have contacted all mass media outlets in the Corpus Christi area to explain

the constraints on I-37 reversal, so the public does not expect automatic reversal in the case of any hurricane's approach.

3.3. EOCs should speak with a unified voice. A public information officer should be available to answer all questions from the media, so as to avoid the confusion of contradictory messages going out to the media.

3.4. In areas with numerous media outlets, some effort should be made to distinguish between the message from emergency management and the opinions of media personalities. The latter can vary, and it is not possible to require them all to say the same thing. They should, however, make an effort to coordinate their messages so as to avoid unnecessary confusion among the public.

3.5. Information coming from official sources should be couched in non-technical language, so as to minimize the need for interpretation by the media, which can allow errors to creep into the message.

3.6. Official sources should establish contact with the media as early as possible in an event, so as to minimize the amount of time the public does not know what emergency management officials are doing and advising.

3.7. As much as possible, media outlets should be encouraged to provide all viewing/listening areas with information specific to their needs. This would help local emergency management officials of the smaller communities surrounding large media markets to distinguish between their recommendations and those of the larger city emergency managers.

3.8. Because of the demographics of the impact area, a serious effort must be made by state and local elected officials and emergency management officials to cultivate a working relationship with Spanish-language television and radio stations, in order to ensure that they have the most accurate and timely information possible.

3.9. Media outlets could capitalize on public interest in hurricanes to gain market share by billing themselves as the place to get accurate information in an emergency. This is an opportunity for cooperation between DEM and commercial media outlets.

• **Shelter Management**

Hurricane Bret did not seriously stress the shelter capacity of the state, because it came on shore in a region that is sparsely populated. In spite of this, there were some isolated problems with sheltering. The most problematic issue was staffing of the shelters.

Shelters were opened by the American Red Cross, the Salvation Army, and by several local governments. In some cases, these shelters were opened by local governments when the population requested emergency accommodations. American Red Cross policy does not allow for shelters in coastal counties, since this may discourage needed evacuation of the population and could expose ARC volunteers to harm from hurricanes. Texas' coastal counties are divided into Risk Areas based on surge potential, which were not addressed in ARC policies. In some cases, there was a need for shelters in coastal counties, and the cities were obliged to come up with alternative arrangements. In most cases, the Salvation Army assisted the local governments when they opened shelters. Table 3.1 summarizes shelter data from field interviews with shelter providers and local emergency managers.

Data from the Shelter and Mass Care Coordinator covering ARC and Salvation Army shelters shows that at peak demand on the morning of Monday August 23rd, 50 shelters were open, with 9,629 occupants. This number declined rapidly throughout the day, and most shelters were closed by Tuesday evening. Some shelters closed early on Monday, then had to reopen as the storm moved on shore and inland flooding occurred. American Red Cross reported serving 17,072 meals, Salvation Army reported 11,889 meals, and an unknown number of meals were served by other shelter providers such as churches and school districts.

Several jurisdictions reported problems coordinating with the local ARC chapters. Since it is a major provider of shelter, it is particularly important for the Red Cross to communicate policies effectively so the public has realistic expectations about shelters. There were cases of people failing to evacuate because they expected to do the same thing they had done "last time," which may have been many years ago. Several shelter providers mentioned that evacuees did not know to bring bedding with them. Cots were not available for some people that needed them. A backup stock of bedding has been positioned in Austin for the use of special needs populations that do not have access to other provisions.

Organization /Location	# Shelters	# People	Demand/ Supply	Open-Close	Problems
Red Cross, South TX region	13	>6,500	Adequate	08/21pm-08/23am, 08/23am-08/24am	Confusion over shelter locations, Staff shortages, Flooded access roads Shortage of registration forms Loss of power in one shelter Lack of provisions for special needs population
Salvation Army McAllen	2	>650	Adequate	08/21am-08/23am	Poor distribution of evacuees between shelters, Shortage of bedding
Hanna HS Brownsville	1	1,000	More than adequate	08/21pm-08/23am	None
Red Cross Victoria	3	421	Adequate	08/22am-08/23pm	Shortage of staff Lack of medication
Red Cross San Antonio	15	2,381	Adequate	08/22am-08/24am	Shortages of staff, bedding, medication, AC
Brooks County	2	>400	More than adequate	08/22m-08/23am, 0823pa-08/24	Shortage of staff
Kenedy county	3	NA	Adequate	08/22-am08/23am	None
Refugio County	2	NA	More than adequate	08/22-08/23	None
Kleberg County	1	<50	More than adequate	08/21pm-08/23am	None
Edinburg	3	>600			
Atascosa County	6	747	Adequate	08/21pm-08/24am	Confusion over shelter locations, Lack of staff, bedding, AC

Table 3.1 Shelter Summary

While there was no shortage of shelter capacity, there was a shortage of trained staff willing to undertake the responsibility of managing shelters. School district staff, church members, or other local people stepped into the gap when necessary.

Private facilities that care for special populations were not always prepared to evacuate and find shelter for those in their care. In some cases, plans had not been updated for 10 years. These populations were cared for by local governments that were already under some strain.

There was little communication between evacuating jurisdictions and host counties. Although many evacuees from coastal counties did proceed to larger communities such

as San Antonio, many also stopped at smaller towns along the way, such as Pleasanton or Falfurrias. Such small communities provided shelter to significant numbers of evacuees. The following recommendations are made based on the interviews with shelter providers:

3.10. Private entities such as nursing homes should be informed of the state requirement that they plan for relocation of their patients in case of an evacuation, and a review process should be developed to ensure that they have emergency plans that are current, frequently reviewed, updated, and exercised.

3.11. The Red Cross needs to publicize its policy on providing shelter in coastal counties, and explain the logic of its position. This will hopefully encourage people to take an emergency seriously and more likely to evacuate. A reevaluation of its shelter policy is recommended in light of the varying potential for surge-related flooding along the Texas coast.

3.12. Lists of items required by evacuees should emphasize bedding and prescription medications, because shelter providers frequently mentioned that evacuees did not bring these.

3.13. Shelter locations must be communicated accurately. Reliance on coded lists, in which the number of a facility on the list of shelter locations was not related to the order in which it was opened, caused unnecessary confusion.

3.14. Smaller communities along evacuation routes should be included in shelter planning.

3.15. Plans need to be made to cover the requirements of special needs populations in case of emergencies. Such plans may involve local churches, hospitals, or other organizations, as well as, or instead of the Red Cross.

3.16. Evacuating jurisdictions should ensure that communities along their evacuation routes are advised when they issue evacuation requests. This could be accomplished by sending the evacuation requests to the DDC and the state EOC, who could then pass it on to communities along the evacuation routes and host communities.

3.17. A serious effort should be made to find shelters with air conditioning, especially for the use of the elderly and infants who are more vulnerable to the effects of heat exhaustion.

3.18. The state shelter assessment program should be expanded to include communities inside risk zones in order to support local efforts to provide adequate shelters in areas not threatened by storm surge.

- **Traffic Management**

The main agencies involved in managing evacuation traffic are Texas Department of Public Safety-Highway Patrol and Texas Department of Transportation, together with the various county Sheriffs and municipal Police Departments. Interviews were conducted with personnel from the two state agencies in the Brownsville and Corpus Christi Study Areas. This section will discuss the findings from this series of interviews.

The extent of evacuation in Hurricane Bret cannot be known precisely, in part because there were few traffic counters out on the roadways. Evacuation data was available from two counters, one on Park Road 22 on the JFK Causeway between Corpus Christi and Mustang Island, and one at the intersection of I-37 and US 59.

The Park Road 22 counter indicated that evacuation from Mustang Island began on Saturday, August 21 at about 9 pm and continued until about 10 am Sunday the 22nd. A total of 8,468 vehicles passed over the counter during that period, compared to 3,288 in the same period of 1998, an increase of 5,188 vehicles.

Evacuation traffic at the I-37 counter increased Saturday afternoon at about 4 pm and remained heavy for 24 hours. During that period, 34,170 vehicles crossed over the counter, compared to 5,468 during the same period in 1998, an increase of 28,702.

TXDOT and DPS personnel were asked about specific roadway problems in their areas. Traffic managers in the south Texas area used barricades, traffic control points, vehicle assistance, redirection of traffic, coordination of traffic lights and electronic message boards to help manage traffic. Their main concerns were the timely evacuation of South Padre Island, control of access to US 77 north of Raymondville (in order to alleviate pressure on the intersection with I-37 north of Robstown), and uncertainties about traffic coming across the numerous border crossings between Mexico and the U.S.

They felt the roadway capacity was adequate in relation to demand, and reported no major bottlenecks or traffic jams. As is customary, South Padre Island evacuated before any other communities in the region, without incident. There were isolated instances of vehicles trying to evade the barricades on US 77. One trucking company, under pressure to maintain the just-in-time delivery schedule required by a maquiladora plant expecting a delivery, attempted to travel south while winds were still high, gusting at up to 80 mph,

but was prevented from traveling during this period. Extra traffic control personnel could have been used at the intersection of TX 100 and US 77, but the congestion did not last long.

TXDOT and DPS personnel in the lower Rio Grande Valley reported highly cooperative relationships with other federal and state agencies and local law enforcement. They did not run any hurricane tracking programs or evacuation time estimates themselves. They relied on information they received from DEM over the TLETS network, the local National Weather Service bureau, and the National Hurricane Center, as well as public sources such as the Weather Channel.

The situation in the Corpus Christi Study Area was more complex. Some confusion arose from the fact that forecasters predicted a more westerly track for Hurricane Bret, which would have taken it onshore at Las Pescas, Mexico. The storm did not take this turn to the west until quite late in its progress. In addition, the storm escalated rapidly, growing from a category 2 to a category 4 storm within the space of a few hours. The window of opportunity to evacuate was severely restricted, and local officials expedited their evacuation decision in order to maximize safety. The opening of the TXDOT EOC was also delayed.

Forecast uncertainty, together with the rapid onset of the storm, may explain the somewhat contradictory responses received to questions about the adequacy of the evacuation routes, and the traffic congestion experienced. While most informants believe the roads are adequate for evacuation if people leave in good time, this in fact did not occur, and most people left within a short period of time, causing long delays on the road.

The most exposed communities, located on the barrier islands and on the bay, were able to complete their evacuations in good time. Ferry service to Port Aransas was interrupted at 4 pm on Sunday.

Specific problem areas included an area under construction on US 77 in Refugio, the intersection of 358 (South Padre Island Drive) and I-37, the intersection of US 77 and I-37, and a rest stop on I-37 in San Patricio County not far from Corpus Christi. In spite of the traffic jams, no major accidents were reported.

There was confusion among the decision-makers and the media on the reversal of I-37's southbound lanes. Some media reported the reversal as a fact, when it was only a remote possibility, because planning for such action had not been completed. The "I-37 Conversion Plan" has since been completed. While the plan is well understood by

TXDOT and DPS personnel, there is still some confusion about the plan among the media and the general public. Traffic management personnel are confident that the plan will relieve some of the congestion on I-37 in the event of a hurricane, but do not believe it will completely absorb all the extra traffic generated by an evacuation if the public does not heed early warnings and requests for evacuation.

Based on this series of interviews, the following recommendations are made:

3.19. Educate the media and the public on the specific conditions under which southbound lanes on I-37 will be reversed. Mount a public awareness campaign using all available channels of communication to deliver a unified message about the reversal.

3.20. Opening of different agencies' EOCs should be coordinated, since they rely on each other for support during hurricane operations.

3.21. Political decision-makers and technical personnel must work together on evacuation decisions in major population centers such as Corpus Christi. Decisions should not be reached in isolation from agencies charged with their implementation, and should not be announced in the absence of agreement among all the principals.

3.22. Mount a public education campaign to increase awareness of alternate evacuation routes and destinations.

3.23. Increase the number of evacuation roadway network signs on all routes to aid in public awareness, both of the need to plan for evacuation and of the variety of possible routes available to them.

3.24. Work with local radio stations to improve reporting on traffic conditions during evacuations.

- **Prison Evacuations**

Hurricane Bret affected an area with several prisons. Steps were taken by the Texas Department of Criminal Justice to remove inmates from the storm's path by evacuating several prisons in TDCJ-ID Region IV. This Region has 11 prisons, 2 state jails and 2 privately-run prisons housing inmates from multiple states, including felons from Texas. Four of these units were evacuated: Lopez, Segovia, Willacy, and the Glossbrenner unit. Approximately 3600 inmates were housed in these facilities.

The decision to evacuate the prisons was made by TDCJ administrators, who also determined which prisons were to evacuate and which were to serve as hosting facilities. The decision was made at 1pm on Saturday the 21st, and evacuation was initiated at 5pm.

Since the Region only has 12 buses, and each bus holds 37 prisoners, TDCJ brought in buses from other Regions. A total of 48 buses were used, with each bus making several trips. Destinations were determined by TDCJ administrators in Huntsville, based on the custody level of the prisoners and the capacities of the host facilities. There were no accidents or injuries, although there were some breakdowns, which were handled without incident by sending wreckers to pick up the buses and more buses for the inmates. Each bus carried medical and supervisory staff. By 6 am all prisoners had arrived at their destinations.

Upon arrival, prisoners were housed in the facilities' gymnasiums, with temporary bedding. Accompanying staff was housed in military or other housing by the host facilities. The decision to return was made at about 8:30 Monday morning, and all prisoners were back by Tuesday the 24th.

DPS personnel were used to escort the prison evacuation. This worked well, but it left the DPS short of staff when they were needed for traffic control in south Texas. As it happened, the prison evacuation was carried out at night, before most civilians were on the road, which was fortunate. Some concerns were expressed about the centralized nature of the TDCJ's decision making process. It was felt that the region involved in the evacuation should make the decision to evacuate and decide where to send the prisoners because they are closer to both the weather situation and the inmates.

There was a hurricane evacuation plan for one prison, but not for the system as a whole. Given this fact, the operation went quite well. Based on lessons learned from this experience, the following recommendations are made:

3.25. An evacuation plan should be developed for each TDCJ Region. The development of these plans should include both the evacuating units and the host units.

3.26. Provisions must be made for using TDCJ personnel to escort evacuation buses, because the DPS does not have enough people to cover both civilian and inmate needs.

3.27. Evacuation decision making should be decentralized as much as possible, including the administrators of individual prisons because they are most familiar with the populations in their care and the potential problems of an evacuation. An effort should be made to make these decisions early enough to allow most prisoners to be moved before the civilian population evacuates.

3.28. TDCJ should coordinate its operations with other agencies. This can be facilitated by such measures as maintaining a presence in key local EOCs during an event, and by reviewing TDCJ evacuation plans with local emergency managers and DPS.

3.29. Policies on wind tipping speeds of TDCJ buses should be updated based on the best technical advice available.

• Emergency Management

Local emergency management personnel were interviewed in the Matagorda, Corpus Christi and Brownsville Study Areas. During the interview process, it became apparent that there were two main population centers involved by Hurricane Bret, the area around Corpus Christi and the area around Brownsville. These two areas had distinct experiences and concerns. In addition, Willacy, Kleberg, and Kenedy counties, which comprise the area in between these two population centers, had some distinct concerns because of their low population density. Thus, the interview results are presented in three sections: the lower Rio Grande valley area, Willacy, Kleberg and Kenedy counties, and the Coastal Bend area in and around Corpus Christi. A summary of interview results is presented in Table 3.2.

Lower Valley

In the lower Rio Grande Valley, there are several coastal cities that may need to evacuate in the case of a hurricane. South Padre Island evacuated, because it is all in Risk Area 1. Compliance with this request was high. Officials in the City of South Padre Island take steps to ensure that the citizens evacuate early and that everyone does in fact leave. City services are turned off after all but essential personnel have left the island. City government is moved to a hotel in McAllen.

In addition, the city of Port Isabel issued a request for evacuation, but officials estimate that only about 20% of the population left. Emergency management personnel feel that the population is highly resistant to evacuation requests and hurricane warnings. Few people left in spite of the use of bilingual warning messages delivered by means of TV, radio, loudspeakers in the neighborhoods, and telephone messages for the disabled.

Some of the lower-lying districts of Cameron County, mostly in the colonias and nursing homes, were evacuated, with the assistance of county Emergency Management, which provided transportation (school buses) to shelters in Hidalgo County. About 1400 people were evacuated. This evacuation ran smoothly, and no problems were reported. The decision about which areas to evacuate was based on the history of flooding in the different colonias. Border Patrol agents assisted the county by providing generators for shelters and help with security.

The City of Brownsville is in Risk Areas 4 and 5, so no evacuation was requested in Hurricane Bret. The main problems for local emergency management have to do with the city's proximity to Mexico. There is some concern that evacuation in the case of a major hurricane would be difficult, for several reasons. First, many families are split, with some members living on the U.S. side of the border and others living in Mexico. In the event of a hurricane, officials think that much time would be spent trying to reunite families before moving inland to seek shelter. The situation is further complicated by employment patterns. Some U.S. residents work in Mexico, and vice versa. In the event of a hurricane, parents at work might have to cross the border to pick up children from school before evacuating the danger zone.

Another problem is the pressure employers place on workers to stay on the job. Some workers fear losing their jobs if they leave town for a hurricane. With the just-in-time delivery system common in modern manufacturing, components are moved around the country with very precise timing, and plant managers put pressure on truck drivers to keep moving through the danger zone as well as on workers to stay and staff the plants as long as possible.

The Brownsville Police Department has instituted a communications system called RIO-COM in an effort to improve interagency communication and coordination during an event. They report good success with the system, but the county EMC still had some trouble accessing their channels. No additional traffic assistance was needed in Hurricane Bret, since evacuation in the county was limited.

Willacy, Kenedy and Kleberg Counties

These counties contain several small cities that are either completely or partially located in hurricane Risk Areas. In Willacy County, all of Port Mansfield and portions of Raymondville, Lyford, and San Perlita were asked to evacuate. Officials estimated that less than 40 % of the population evacuated, including those transported in buses and those that used their own transportation. The storm blew in quite rapidly, and many

people put off leaving until it was too late, then requested emergency shelter in San Perlita, which was provided in a church building. Officials believe the population is complacent about the need to evacuate, and that, although Bret provided a useful drill, it may have increased people's false sense of security.

Sarita is a unique community because of its isolation. It is a very small city, but is the largest population center in Kenedy County, which is overwhelmingly rural. The city officials believe that they are well prepared because their isolation has forced them to be independent. Residents prefer not to evacuate Sarita, but gather in the highest part of town in the school, the courthouse and a church, which are the sturdiest buildings in town. The citizens bring bedding and food for 3 days, and the city and county officials stockpile water and provide an emergency generator. They know that the Red Cross will arrive after 3 days to replenish their food stocks. This is what happened in Hurricane Bret. Some people prefer to ride out the storm in their houses, even on isolated farms. County officials estimate that only 4 families left town. Bret was not a large enough storm to seriously threaten their safety.

Kleberg and Kenedy Counties and the City of Kingsville share an Emergency Management Coordinator. Evacuation was advised on Saturday morning, but officials estimate that less than 25% of the population left. Sirens and radio were used to disseminate the evacuation request. Although the Red Cross had no plans to open shelters in Kingsville, the city government opened up a school, where fewer than 50 people took shelter.

The most serious problem in Kleberg was the absence of the county judge, who did not report to the EOC although he was in town at the time. In his absence, the mayor of Kingsville took on the responsibilities of Emergency Director.

Coastal Bend

Port Aransas was the first city in the area to evacuate. This city is located on a barrier island, so city officials are accustomed to hurricanes and have done a great deal of planning and preparation. All visitors and residents were asked to leave the island, and services were cut off to discourage those who might wish to remain behind. A skeleton crew was kept on in the County office building, which was built to be hurricane resistant and provide space for the EOC, as well as sleeping and cooking facilities. Hotel rooms inland were rented for the families of staff that had to stay in town. City officials take care to evacuate in good time because of limited access to the island. The causeway is flooded first, and is closed while ferries, which can run in up to 5 foot tides, are still open. No problems were reported in Hurricane Bret, other than some uncertainty about the

status of the causeway. Evacuation was completed by midnight on Saturday, with compliance estimated at over 80%.

Corpus Christi is the largest city in the Coastal Bend area. As such, it dominates regional media attention and affects its neighbors much more than they affect it. There were some well-publicized problems with the evacuation of Corpus Christi. Some of the difficulties were due to the nature of the storm, which accelerated quickly, forcing local officials to speed up response plans and surprising public. The early forecasts predicted landfall in northern Mexico. The Corpus Christi EOC was activated at 10 am on Saturday the 21st when hurricane warnings were extended to Baffin Bay. There were no watches or warnings north of Baffin Bay until 4 pm, when the hurricane warning was extended to Baffin Bay and a thunderstorm warning and hurricane watch was issued for areas north of Baffin Bay. The4 pm ESTED run indicated that it was too early to evacuate. Within three hours the storm intensified to a category 4 and the ESTED run indicated that it was too late to evacuate all areas at risk. The official advisory was not issued until 10 pm, when hurricane warnings were extended north of Baffin Bay to Port O'Connor. Local officials expedited evacuation decisions to adjust for the storm's increased intensity and the changed forecast track.

Residents of low-lying areas were advised to evacuate at 10 pm on Saturday, and all residents were advised to evacuate at 8 am on Sunday. There were some problems with flooded evacuation routes. In particular, the South Padre Island Drive causeway is quite low and tends to flood whenever there is heavy rainfall. The major problems, however, were on I-37. Most evacuees chose this route, leaving others underutilized, while I-37 experienced major congestion. Officials attribute the congestion in part to the fact that people hesitated to evacuate early, then "everybody left at the same time."

Official estimates of the number of people who evacuated vary, but the consensus is that a very small percentage of the population actually left. The Red Cross did not open shelters, but there was demand for shelters, and the city plans to open some schools as shelters in the future.

Two measures have been undertaken to avoid such a situation in the future. The city's EMC has devised a system of evacuation zones, in which each zone has a designated evacuation route and evacuation times are staggered, with the most vulnerable areas leaving first. The city is in the process of distributing maps of this system and publicizing it in other ways.

The second measure is the plan for reversing the direction of traffic on the two southbound lanes of I-37. This plan was developed after much discussion and is a collaborative effort of many agencies and jurisdictions. It is very difficult to control all the access points on I-37 so as to make the reversal safe. The plan will require a great deal of manpower to implement, and the cooperation and collaboration of all jurisdictions along the route to San Antonio. The plan is only to be implemented for the most dangerous hurricanes, under certain conditions. At best, most officials expect it to ease congestion somewhat, but not to avoid it altogether, especially if the public acts in the belief that there will be no congestion and delays evacuating too long. There is some concern among officials that Hurricane Bret may have actually increased public complacency and reduced the likelihood that people will evacuate in good time because the hurricane itself had little impact on large population centers and the evacuation congestion received so much media coverage.

Officials in Aransas County began advising a county-wide evacuation at 1 am Sunday. Much of the land in the county is located in Risk Area 1, and populated areas located in Risk Areas 2 and 3 have to travel through Risk Area 1 in order to evacuate. Therefore, the evacuation recommendation goes out to all areas in the county. It is estimated that 70% of the population complied with the evacuation request, which was disseminated by TV, radio, telephone, and meetings as well as by the police, sheriff, and fire departments cruising the neighborhoods with loudspeakers. Nursing homes and other special needs populations had to be assisted with transportation, which was provided by school buses. The method of disseminating the call for evacuation was not very efficient, and some neighborhoods were notified more than once, while others received no notification.

Most of the population of San Patricio County lives within the 5 Risk Areas. The EOC was activated Saturday evening but the County Judge was out of town, so the county commissioners participated in decision making. An evacuation recommendation was made about 9pm Saturday evening for Risk Areas 1-3, and Sunday morning at 6 the entire county was advised to evacuate. It was estimated that up to 80% of the coastal areas and less than 50% of the upland areas evacuated.

Traffic on I-37 was bad throughout Sunday morning, but had cleared up by noon. There was inadequate notification from Corpus Christi DDC about when an evacuation was initiated and what kind of traffic flow San Patricio county could expect. The media overemphasized the use of I-37, to the neglect of alternative routes to the west. One trouble spot was a highway rest area, which had to be closed to ease traffic flow. Train traffic continued uninterrupted through the evacuation and caused some delays as well.

Calhoun County activated its EOC in Port Lavaca Saturday afternoon. There was some disagreement about the need to evacuate, but coastal and low-lying areas were advised to evacuate about 1 am, and a county-wide request went out at 5 am. The call for evacuation was disseminated primarily by telephone and TV. It is estimated that between 6,500-8,000 people out of a population of about 20,000 actually evacuated. No problems were reported with the evacuation. Some communication problems, such as dead spots within the transmission area, were reported, however.

Refugio County experienced minimal impacts from Hurricane Bret and the resulting evacuation. The EOC was opened briefly, but there was no need to evacuate any areas in the county. A shelter was opened, and about 5 elderly individuals were cared for. No traffic congestion was reported.

Bexar County is a host county for people in the Corpus Christi Study Area. They activated their EOC Saturday afternoon. A staging area was set up by the Red Cross at McCreeless Mall on Sunday to tell evacuees what shelters they should go to. There were reports of some confusion at this site, but these were from early in the afternoon. No traffic problems were reported in the San Antonio area, and the number of refugees did not stress available shelter space.

- **State EOC**

The DEM EOC in Austin was already in operation when Hurricane Bret appeared, because of the wildfire situation. The first message on Hurricane Bret was sent to the Emergency Management Council on the morning of Friday the 20th, and the first hurricane briefing to the Council was at 3 pm on Friday. The center moved to 24-hour hurricane operation about 8 am on Saturday the 21st. Hurricane operations ran until 4 pm on Wednesday the 25th.

Because of the structure of emergency management in Texas, the role of the State EOC during an emergency is mainly to support local emergency managers and political officials as they make decisions. Much of DEM's work is done before and after the emergency period.

During Hurricane Bret, DEM supported local officials by running evacuation time estimation software and publicizing the results on the DPS network, TLETS. DEM served as a center for information on evacuations and sheltering. Media personnel were present at the DEM to receive regular situation updates. The only problem reported within State EOC operations was certain gaps in the flow of information from the coastal jurisdictions affected by the storm. Information processing was slowed somewhat

because the information flow was not fully automated. This issue is being addressed with refinements in the information processing procedures. Bret was a relatively small storm, so the state's emergency management capacities were more than adequate.

• General Problems

In the course of these interviews, several themes recurred. These will now be addressed, and a series of recommendations for improving local and state level emergency management will be made. HES products will be dealt with in the next chapter.

• Texas law does not provide for mandatory evacuation in case of hurricanes. Several local officials expressed some concern with this. They resort to the use of "forceful" language and, in the case of island communities, somewhat coercive measures in an attempt to increase the percentage of the population in their jurisdictions that actually does evacuate. Several informants expressed a desire for a change in legislation that would allow them to require an evacuation. Many jurisdictions did not have formal evacuation recommendations signed by the legally responsible authorities.

• A related issue is the relationship between the officials with legal responsibility for directing operations during an event and those with the responsibility for managing the counties' emergency management organizations and operations during non-crisis periods. The individuals with the legal authority, the County Judges, in most cases have little or no training in emergency management, and do not manage emergency resources on a day-to-day basis, so they have little familiarity with the capabilities and needs of their jurisdictions in a disaster. The individuals with the responsibility for day-to-day operations, the Emergency Management Coordinators, do not have the authority to do what they believe is necessary in an event. This causes problems for both sides. In the best of cases, the County Judge and EMC are able to work together quite efficiently and effectively. In other cases, personality conflicts can arise, and emergency management and crisis decision-making suffer. There is fundamental mismatch between the distribution of expertise and authority. There is the potential for gaps in communication, as when messages or mail are addressed to the Emergency Management Director and never make it to the office involved in providing emergency management services.

• Two conference calls were made during Hurricane Bret. Some of the local emergency managers expressed the need to be included in these calls. DEM was in the process of

changing conference call procedures at the time, and the localities were not all aware of what the current system was and how to access the information they needed.

• There were some reports of calls to DEM going unanswered, or of having phone numbers that did not connect the callers to the people they were trying to reach.

• One of the major issues is the lack of data on evacuation. There is no way to tell how many people evacuated, because of a lack of traffic counters. Therefore, any estimates of evacuation compliance are highly subjective guesses based on the individual's knowledge of local traffic patterns, social systems, and other factors.

• Local emergency managers would like to have access to information on what families in their jurisdictions asked for aid from FEMA, in order to offer assistance with mitigation and preparedness. Household data is considered confidential, however, so cannot be shared with local emergency managers. Few of the emergency managers knew anything about the Hurricane Liaison team or used them in any way.

• Several of the smaller jurisdictions feel that their concerns are overlooked because of their relatively smaller populations. They emphasized the fact that they have distinct concerns, and that their physical, social, economic and political contexts are different from those of the larger cities.

Based on this series of interviews, the following recommendations are made:

3.30. Emergency Management Directors must have some training in emergency management.

3.31. A study should be made of the feasibility of mandatory evacuation in Texas. The study should be performed in an open, inclusive manner so that the pros and cons of such a policy can be debated and consensus can be reached. In the absence of mandatory evacuation, guidelines should be developed that can help raise the likelihood of evacuation from Risk Areas where it is recommended.

3.32. Currently, there is one Regional Liaison Officer for a large area of South Texas, extending from San Antonio to Brownsville. This territory is too large and varied to be adequately covered by one person. Consideration should be given to splitting this territory between two or three Regional Liaison Officers.

3.33. The number of traffic counters on evacuation routes should be increased. This should be done as soon as possible, to build up a database of typical traffic

on evacuation routes for the purposes of comparison with traffic during an evacuation. This will help emergency managers have a better idea of how many people are actually evacuating, when they start to leave, how slow traffic moves, and other information that is not currently available.

3.34. If possible, some means should be found for FEMA's information on hurricane damages to be shared with local emergency management coordinators to help them better prepare their jurisdictions for hurricanes, while at the same time protecting the privacy of those requesting aid. One possibility would be giving local emergency managers information on number of requests made by people living in each zip code. Moreover, household averages, by zip code, might be feasible.

3.35. DDCs must ensure that at least a two-person crew of telephone operators is always available during activation of the EOC, and that local emergency managers, county sheriffs, police departments, fire departments, mayor's offices, county judge's offices and all other agencies have the correct telephone numbers for use during an activation.

3.36. Consideration should be given to finding an alternative to TLETS that can be geared specifically to emergency management. TLETS carries many messages not of value to emergency management, which can increase confusion during an event. In some cases, the local emergency management offices are not conveniently close to the DPS location that has TLETS. In such cases, some communications link should be established by the DPS and local emergency manager. Such an emergency management network could be run over the Internet, since most local emergency managers have web access or could get it fairly easily.

3.37. The possibility of renaming the Study Areas should be considered. The purpose of this step would be to address some of the concerns of the smaller jurisdictions. For example, the area currently known as the Corpus Christi Study Area could be called the Coastal Bend Study Area, and the area currently known as the Brownsville Study Area could be called the Lower Valley Study Area.

3.38. The cities that border Mexico need to study the issues that could arise during a hurricane and develop joint emergency management plans with their cross-border neighbors. They should be assisted in this effort in any way possible.

3.39. County Judges and other political officials should take care to issue signed evacuation recommendations that give precise information on which areas of their jurisdictions are being asked to evacuate. This may help increase compliance with evacuation advisories.

3.40. It would be helpful to have Forecast Advisory updates from NHC at more frequent intervals. This would encourage local officials tto think ahead about what responses might be needed if there are sudden changes in a storm's characteristics, such as those that occurred when Hurricane Bret changed from a Category 2 to a Category 4 storm between two updates.

3.41. Improvements to the information systems at DEM should continue. Much of the data needed for decision making could be automatically downloaded from the web to a server, and accessed by anyone who needed it. All output from DEM hurricane programs could also be made available on the web, which would simplify access by local emergency managers. DEM staff should include more specialists in information technology to adequately address these issues.

3.42. No single decision support program provides a complete picture of the situation. Therefore, it is recommended that the state and local communities further develop their capabilities in the use of several systems such as HURREVAC.

Chapter 4 Assessments of HES Products

This chapter is based on information from the interviews and the mail survey. Local and state officials and members of the news media were asked to evaluate HES products during interviews, and the public was asked to evaluate sources of information in the mail survey. The purpose of this chapter is to find ways to improve HES products, based on the users' reactions. The HES products covered in this chapter include: Storm Atlases and Hurricane Contingency Planning Guides for each of the five Study Areas (Lake Sabine, Houston/Galveston, Matagorda, Corpus Christi, and Brownsville), The Official's Guide for Hurricane Preparedness, the training video for local officials, Risk Area Maps with Hurricane Survival and Evacuation Tips, and the ESTED-DERC computer program.

Table 4.1 shows data on the use of decision tools by local emergency management officials. The Storm Atlases, Contingency Planning Guides, and Official's Guide were used by less than half of the jurisdictions in the study, but there were no negative comments on them. It is hoped that these documents will be more useful when the process of placing them on the web is completed. This will allow for more frequent updating of these items, as well as allow for computer searching of their contents.

ESTED and DERC were the most controversial of the HES products. Only one of the local emergency managers interviewed was completely satisfied with ESTED. Some considered it satisfactory, but most felt it needed some improvements. The most frequently cited problem was the antiquated user interface. Other respondents mentioned the sensitivity of the program to slight input errors, because the runs are done in a time of some stress and in a fairly chaotic environment, so it is easy to make typing errors. The program also gives out too much information, according to some users. They would like to be able to target the output more to their specific needs, instead of getting information for the whole coastline. Some smaller jurisdictions do not even use it, for various reasons such as a lack of computers or of skills and training. These jurisdictions relied on DEM to run the program and looked at the data on TLETS, the DPS network. This seems to be an adequate solution for small jurisdictions with few resources.

Even the jurisdictions that ran ESTED also relied on other programs such as HURRTRAK and HURREVAC, because they offer mapping capabilities that are very useful when presenting data to elected officials and the public. It was felt that DERC, while fairly satisfactory, does not give enough specific information on the significance of impacts to the different types of construction in an area.

Jurisdiction	EOC Activation	Evacuation Requested	Decision Tools	How well tools performed	Information sources
San Benito	08/20 6am	none	ESTED, DERC, HURRTRAK Storm Atlas, Evacuation Maps	All rated Excellent	TLETS, NWS, Weather Channel, Internet, scanners, HAM radio
City of South Padre Island	08/20 3pm	08/21 9am	Storm Atlas, Evacuation Maps	ESTED too cumbersome and slow and lacks visual interface, Maps hard to understand	Weather Underground, NWS, Weather Channel
Port Isabel	08/19 pm	08/20 pm	Evacuation Maps	Satisfactory	NWS, Weather Channel, County Judge's Office
Cameron County	08/20 8:20 pm	08/21	ESTED, DERC, HURRTRAK, Storm Atlas, Contingency Planning Guide, Evacuation Maps	Rated excellent or good	RLO, NWS, Weather Channel, Internet
Brownsville	08/21 7am	none	ESTED, DERC, HURREVAC,	Rated good	DEM, Internet, NWS, Weather Channel
Willacy County	08/21 am	08/21	ESTED, DERC, HURRTRAK, Slosh models, tides, Storm Atlas, Contingency Guide, Official's Guide, Evacuation Maps	Did not do own ESTED and HURRTRAK runs because only got computers one month before Bret; relied on Cameron County for information. Rated very satisfactory	FEMA, DEM, Internet, NWS, Weather Channel
Kingsville/ Kleberg/ Kenedy County	08/20 7pm	08/21 am	ESTED, DERC, HURRTRAK, CAMEO, SLOSH, Contingency Guide, Official's Guide, Evacuation Maps	All rated good	DEM, NOAA, Internet, AccuWeather, CNN, Weather Channel, DEM
Sarita	08/21?	08/21?	none	NA	Kleberg/Kenedy County EMC
Port Aransas	08/20 pm	08/20 pm	ESTED, Tides	Satisfactory	DEM, NWS, Weather Channel, TV
Corpus Christi	08/20 10 am	08/21 10 pm	ESTED, DERC, HURRTRAK, HURREVAC, SLOSH	ESTED-DERC poor, SLOSH satisfactory, HURRTRAK and HURREVAC excellent	HURREVAC download, Internet, NWS, Weather Channel, TV
Aransas County	08/20 10 pm	08/22 1am	ESTED, SLOSH, Tides	SLOSH AND tides good, ESTED needs improvement	DEM, NWS, Weather Channel
San Patricio	08/21 pm	08/21pm	ESTED, HURRTRAK, SLOSH, Evacuation maps	ESTED rated poor, HURRTRAK satisfactory and SLOSH good	FEMA, DEM, TLETS, NWS, Weather Channel, TV
Calhoun County	08/21 pm	08/22 am	ESTED, HURRTRAK, HURREVAC, Tides, Inland winds	ESTED not user friendly, HURRTRAK and HURREVAC good to excellent	DEM, NWS, Weather Channel, KHUT, Internet, Hurricane Liaison Team, NHC
DEM in Austin	08/21 am	NA	ESTED, DERC, GDS, Storm Atlases, HURRTRAK	GDS of limited use, HURRTRAK much improved ESTED and DERC need improvement	FEMA, NWS, Internet, Weather Channel, DPS, Hurricane Liaison Team, other state agencies, commercial media

Table 4.1: HES Performance

The Risk Area Maps were frequently used by emergency managers as public information documents to be handed out at town meetings, at retail centers, or made available in other ways. Most comments were favorable, but a few problems were noted. The most common of these was that the evacuation routes needed to be highlighted more. Some felt that the concept of risk areas was too difficult for the public to understand. Several emergency managers needed more Spanish-language products. One emergency manager disagreed so strongly with the clearance times that he did not use the Risk Area Maps at all. Comments from the survey indicated that most respondents were fairly well satisfied with the quality of the information they received. These data will be summarized in the next chapter.

Based on the interviews with local and state level emergency management, the following recommendations are made:

4.1. Redesign ESTED and DERC to be more user-friendly. The most important thing is to provide a graphical user interface, which will make it much easier to get around the program and get what is needed out of it. As part of this redesign, all calculations and algorithms should be checked for accuracy.

4.2. The process of putting all HES products on the web should be continued. This will make them easier to update, and easier to search quickly for needed information.

4.3. Make all public information available in Spanish, both on the web and in paper copies.

4.4. Put the Risk Area maps, including evacuation routes and survival tips, on the DEM website for easy public access.

4.5. Continue to supply paper copies of the Risk Area maps, with evacuation routes more clearly marked and updated survival tips. Not all households have internet access, and those that do may lose that access in a hurricane. Encourage local emergency managers to make these documents readily available to their citizens.

4.6. Improve the capabilities of DERC to include information on the type of land use that will be affected by a hurricane. This would be possible to do quickly from a GIS system. Such a system would also be useful to improve the analytic capabilities of ESTED.

4.7. Review all clearance times given by ESTED, to make sure they incorporate current road conditions, population levels, surge data and findings from the behavioral survey.

Chapter 5 Evacuation Behavior

• Survey Participation

This chapter is based on a mail survey of a random sample or residents in Nueces, Kleberg, Kenedy, Willacy and Cameron counties[1]. These counties were chosen for the survey because they were the most affected by the storm and by official response to the storm. The sample was stratified to reflect the different population densities of these counties. Four hundred people from Nueces County, were included in the sample, 250 from Kleberg County, 50 from Kenedy County, 250 from Willacy and 400 from Cameron County, for a total of 1350. Three waves of questionnaires were sent to the sample. Of those sampled, replies were received from 312 people, for an overall response rate of 23.11%. When adjusted for undeliverable questionnaires, the response rate is 25.68%. Table 5.1 shows the response rate by county.

County	# Sent	# Returned	# Spanish	Undeliver-able	% Returned	Adj. % Returned
Nueces	400	119	2	54	29.75%	34.39%
Kleberg	250	66	3	25	26.40%	29.33%
Kenedy	50	10	1	15	20.00%	28.57%
Willacy	250	41	2	23	16.40%	18.06%
Cameron	400	76	13	25	19.00%	20.27%
Total	1350	312	21	135	23.11%	25.83%

Table 5.1: Survey Responses

There are several possible reasons for the low response rate. It may be that the high levels of Hispanic residents was a factor, although we included both English and Spanish versions of the questionnaire in every envelope mailed, with instructions to use whichever form the respondent wished. In addition, the number of undeliverables was fairly high, which lowered the response rate. Kenedy County in particular suffered from this, as 30.00% of the questionnaires were returned as undeliverable. The rural nature of Kenedy County may account for this high rate of undeliverables. The low response rate limits our ability to draw statistical inferences about behavior in the different counties. However, we can examine the data closely to discover important patterns in the results.

The first question in the survey asked the respondents in which Risk Area they were located. These data enable us to evaluate the responses by Risk Area as well as by county. Table 5.2 shows the number of responses by Risk Area. There were 278 responses to this question. The largest number of respondents live in Risk Area 5; Risk Area 3 is the second most populous, and Risk Area 1 is the third most populous. The bulk of the Risk Area 3 population is in Corpus Christi, while Brownsville and other

cities in Cameron County are located in Risk Area 5. The bulk of the population in Risk Area 1 is located on the barrier islands.

Risk Area	N	Percent
Risk Area 1	36	12.9
Risk Area 2	11	4.0
Risk Area 3	81	29.1
Risk Area 4	13	4.7
Risk Area 5	130	46.8
None	7	2.5

Table 5.2: Responses by Risk Area

• Sources of Information

Respondents were asked several questions about their sources of information on Hurricane Bret. The first of these asked to what extent they relied on local newspapers; local radio stations; local television stations; national television (network news and the Weather Channel); the internet; friends, relatives, neighbors, and coworkers; local authorities; or other sources. Respondents were asked to rank the degree to which they relied on these sources from 1 for "not at all' to 5 for a "very great extent." The results are shown in Table 5.3.

Source	1	2	3	4	5	N	Mean
Local newspapers	52.1%	15.8%	19.7%	3.8%	8.5%	234	2.01
Local radio	18.5%	14.5%	20.5%	16.9%	29.7%	249	3.25
Local TV	2.5%	3.2%	9.0%	13.3%	72.0%	279	4.49
National TV	13.6%	6.4%	14.0%	16.4%	49.6%	250	3.82
Internet	72.2%	6.3%	8.1%	5.8%	7.6%	223	1.70
Friends, relatives	28.7%	22.1%	26.3%	12.9%	10.0%	240	2.53
Local authorities	38.9%	17.5%	20.1%	12.8%	10.7%	234	2.39
Other	87.6%	0.9%	1.8%	1.8%	8.0%	113	1.42

Table 5.3: Reliance on Information Sources

Local and national television channels were the most important sources of information for the majority of respondents, followed by local radio stations. Newspapers and the internet were much less important sources of information. Local authorities, friends, relatives, neighbors and coworkers were relied on slightly more than newspapers or the internet, but not nearly as much as the mass media.

Type of Information	Nueces N=104	Kleberg N=49	Kenedy N=9	Willacy N=38	Cameron N=58	All N=258
Risk area maps	19.2%	16.3%	0	26.3%	31.0%	21.75
Evacuation route maps	29.8%	22.4%	0	30.6%	39.0%	29.6%
Phone #	35.0%	28.6%	11.1%	43.2%	34.5%	34.0%
Hurricane survival tips	52.8%	50.0%	33.3%	44.1%	58.3%	51.7%
Other	7.8%	8.3%	0	5.9%	7.4%	8.7%

Table 5.4: Information from Emergency Managers

Respondents were also asked specifically about types of information they night have received from state and local emergency management personnel. Table 5.4 shows the numbers of respondents who reported receiving the different types of information by county and for the whole sample. The results show that emergency managers have not yet reached a majority of those surveyed. There is also a possibility that people have incomplete memories of the information they have received, because the most cited type of information was the hurricane survival tips, which are printed by the state Division of Emergency Management on the risk area maps, together with the evacuation routes. These maps are available for distribution by local emergency managers, who may also choose another means of distributing this information.

Survey respondents were then asked to rate the quality of the information they received with regards to its specificity, consistency, clarity, completeness and relevance to hurricanes. Rankings range from 1 for "not at all" to 5 for "very great extent." Results are shown in Table 5.5. Respondents rated the quality of the information they had received on the high side in the majority of cases, although some improvement is still possible in all categories.

Extent to which information was...	1	2	3	4	5	N	Mean
Specific	14.5%	8.3%	17.4%	30.6%	29.3%	242	3.52
Consistent	14.9%	10.7%	26.0%	26.4%	21.9%	242	3.30
Clear	11.6%	6.4%	17.6%	28.8%	35.2%	250	3.71
Complete	12.6%	10.6%	19.9%	24.8%	32.1%	246	3.53
Relevant	17.5%	10.9%	27.1%	24.9%	19.7%	229	3.18

Table 5.5: Information Quality

• **Evacuation Participation**

The number of people in each county who evacuated is shown in Table 5.6. These results may be high because those who evacuated may be more likely to respond to the survey.

County	Number of responses	Number who evacuated	Percent that evacuated
Nueces	109	37	33.9
Kleberg	53	18	34.0
Kenedy	9	3	33.3
Willacy	38	8	21.1
Cameron	67	6	9.0
Total	276	72	23.2

Table 5.6: County Evacuation Rates

We can compare the percentage of people in the survey who reported evacuating with the estimations of emergency management and local government officials. In Nueces County, Port Aransas officials estimated that 80% of the population evacuated. They estimate that their current permanent population is about 3,500. This would mean that about 2,800 people evacuated from the island community. Corpus Christi officials estimated that 30,000 cars evacuated the city. Our survey data show that most people who evacuated only took one car. Assuming a modal rate of 3 people per car, about 90,000 people evacuated, or 32% out of a population of 281,453 (1998 Census estimate). The estimated population of Nueces County is 315,469 (US Census 1999 estimate). If 92,800 people evacuated, this is slightly less than one third of the county population, or 29.42%, which is not very different from the survey results.

91.62% of the population of Nueces County lives within Risk Areas 1-3, and most of these are in Risk Area 3. This means that most of the population of the county is vulnerable to the effects of a Category 3 hurricane. The implications of these demographic patterns for hurricane evacuation are serious, especially given the difficulties experienced during the evacuation for Hurricane Bret. Road network capacity may need to be reevaluated in the light of this discussion.

The largest city in Kleberg County is Kingsville. Local officials estimated that about 20-25% of the population evacuated, which is quite similar to our finding that 34% of our respondents from Kleberg County evacuated. Our data from Kenedy County also give a higher estimated evacuation rate (33%) than did local officials, who believed that only "about 4 families" left. The number of responses for this question is very low, however,

so our data are not conclusive. Willacy County officials could only estimate that "less than 40%" of the county evacuated. Our data show that 21% evacuated, but again, the number of responses is quite low.

We had a fairly high number of responses from Cameron County on this question. Only 6 out of 67, or 9%, reported evacuating. This result is consistent with the fact that officials in Brownsville did not request evacuation. Most of the population of South Padre Island evacuated, and local officials reported that about 20% of the population of Port Isabel evacuated. This group, together with the 1,400 people the county evacuated from the colonias, accounts for about 7.9% of the county's population. This figure is slightly more than one percentage point lower than the 9% of the survey respondents who reported evacuating, which indicates that official estimates were quite accurate. This calculation does not include the tourist population of South Padre Island, which of course evacuated, but is not part of the survey sample.

Overall, evacuation rates were low compared to those reported by Baker 1991. Evacuation rates by Risk Area are shown in Table 5.7. Note that less than 30% of the people who live in Risk Area 1 reported evacuating for a storm which, at its height, was a Category 4 hurricane. This is far less than the 89% evacuation rate estimated in the Evacuation Intentions Survey (Ruch and Schumann 1997). The Risk Area with the highest proportion of respondents who reported evacuating is Risk Area 3 (31.6%). Almost 93% of the respondents who live in Risk Area 3 (75 out of 81) live in Nueces County. It is also noteworthy that the 22.8% sympathetic evacuation rate in Risk Area 5 is below the 34% rate estimated in the Evacuation Intentions Survey (Ruch and Schumann 1997). Moreover, the absence of a significant differential between high and low risk areas is quite unusual (cf. Baker 1991)

Risk Area	N	Number who left	Percent
1	34	10	29.4
2	10	2	20.0
3	76	24	31.6
4	13	2	15.4
5	123	28	22.8
None	3	0	.0
Total	259	66	NA

Table 5.7: Risk Area Evacuation Rates

In part this low evacuation rate may be attributed to the rapid strengthening of the storm, but it is important to discuss the significant congestion the Corpus Christi area experienced even with the low evacuation rate. The I-37 Conversion Plan that was developed after Hurricane Bret is not expected to significantly lower evacuation times, in part because significant congestion points exist within the city of Corpus Christi and at the intersection of 77 and I-37, south of the Conversion Point (Region 3 "2000" I-37 Conversion Plan, p. 7). In addition, the plan calls for public notification not later than 24 hours before anticipated landfall, but current estimates show that it would take 29 hours to evacuate Corpus Christi. In the event of a more direct hit on Nueces County, the situation is expected to be significantly worse than in Hurricane Bret.

• Timing, Means, Routes, and Destinations of Evacuation

Table 5.8 shows data on the date of evacuation. Note that most people reported leaving on Sunday. Although only 24 people in Nueces County were able to tell us what date they evacuated, 20 of these left on Sunday, August 22nd. The official request for a county wide evacuation did not go out until Sunday morning at 8am. The hurricane made landfall shortly after 7pm that evening. There was clearly not enough time for a county wide evacuation to be completed by the time it was announced Sunday morning.

County	Thursday 19th	Friday 20th	Saturday 21st	Sunday 22nd	Total
Nueces	0	0	16.7%	83.3%	24
Kleberg	7.1%	7.1%	28.6%	57.1%	14
Kenedy	0	0	33.3%	66.7%	3
Willacy	0	33.3%	33.3%	33.3%	6
Cameron	0	0	100%	0	3
Total	2.0%	8.0%	28.0%	62.0%	50

Table 5.8: Evacuation Date

Emergency managers need to know the number of vehicles they can expect each family to take in an evacuation in order to better predict the levels of traffic congestion that can be expected. Table 5.9 shows the number of vehicles used by those evacuating, and shows that most households took only one vehicle. The average number of evacuating vehicles for the 71 respondents who answered this question was 1.34. This is almost identical to the number estimated in the Corpus Christi Evacuation Intentions Survey (Ruch and Schumann 1997), and is consistent with data from other evacuations (Lindell and Perry 1992)

Number of Vehicles Taken	% of Households	Number of Households
1	66.2%	47
2	22.5%	16
3	11.3%	8

Table 5.9: % Taking 1, 2, or 3 Vehicles

Respondents were asked to describe their evacuation routes. Table 5.10 shows all the routes mentioned, with the total number of mentions each received. The most common evacuation route involved some travel on I-37, which makes sense because 39% of those who evacuated were from Nueces County. The next most common route is 77. Some congestion was reported at the intersection of 77 and I-37. Some of those who reported using 77 entered from I-37 and continued on 77 from there, while others used 77 to get to I-37. 281 and I-35 were the next most popular roads, and a number of smaller roads or other routes were used as well.

Evacuation Route	Number of Times Mentioned
I-37	34
77	14
281	7
I-35	6
44, 83, 141, Surface streets	3 each
490, 285, 624, 665, 181, Airline	2 each
286, 4, 49, 70, 123, 16, 80	1 each

Table 5.10: Evacuation Routes by Frequency

The next question to be discussed is why people chose a particular route. The response choices were "it was on maps I received before the hurricane", "it was recommended by news media during the event", "it was recommended by local officials during the event", "it seemed most logical at the time", and "other". Table 5.11 shows the frequency of these responses. Familiarity with the routes, leading to use of the "most logical" one was by far the dominant category. The second most chosen option was "other." A review of those who responded "other" yielded three responses mentioning traffic or congestion on certain roads, five who went to stay with family or at second homes, and only two who had a preplanned evacuation route, along with several who did not specify why they chose the "other" category. A total of 70 people answered this question.

Reason	%
On Maps	4%
Recommended by Media	0
Recommended by Officials	3%
Most Logical	69%
Other	24%

Table 5.11: Reasons For Choice of Evacuation Route

We also have data on the cities where people stayed after they evacuated. Table 5.12 shows the cities reported as destinations by those who evacuated. The majority of our respondents went to San Antonio, but many other locations were reported as well. With only 36 responses for this question, we cannot draw firm conclusions from these data. However, the variety of responses to this question supports evidence from the interviews that indicates a number of evacuees sought shelter in small towns along evacuation routes.

City	Frequency of Mentions
San Antonio	22
Austin	8
Raymondville, Laredo, Houston	3 each
Ft. Worth, Alamo, Jourdtown	2 each
George West, Callan, Three Rivers, Realitos, Fredericksburg, Buda, Mathis, Beeville, Alice, Waco, Pearsall, Kingsville, Oklahoma City, Riviera, Lyford, Rio Grande City, Santa Rosa, College Station, Donna, Brownsville, Harlingen, Premont	1 each

Table 5.12: Evacuation Destinations

• Reasons for Evacuation Decision

Survey respondents were asked to rate the extent to which the following considerations affected their evacuation decision: seeing storm related conditions; being aware of their own proximity to the coast; hearing an announcement of a hurricane watch or warning; hearing local authorities issue official recommendations to evacuate; seeing area businesses close; and seeing friends, relatives, neighbors, or coworkers evacuating. The results are shown in Table 5.13. In this table, 1=not at all and 5=very great extent.

Private citizens relied mostly on the same cues that public officials and emergency managers used (see Chapter 3). The first three considerations, storm related conditions, proximity to the coast, and hurricane watch or warning, were relied on to a very great extent by more respondents than relied on them not at all. The second group of considerations, official recommendations, business closings, and friends, relatives, or coworkers leaving show the opposite pattern, with more respondents saying they were not at all important in making an evacuation decision than relied on them to a very great extent. Official recommendations were rated highly by only 66 of the 259 people responding to this question, while 58 people rated it as not at all important. It is important not to overrate the persuasive powers of official calls for evacuation, unless they are backed up by clear meteorological and geographic conditions, and supported by the National Hurricane Center and National Weather Service information going out on the Weather Channel and other media outlets.

Consideration	1	2	3	4	5	N	Mean
Storm related conditions	21.1%	9.4%	21.9%	17.4%	30.2%	265	3.26
Proximity to coast	16.1%	8.0%	19.2%	23.0%	33.7%	261	3.5
Hurricane watch or warning	16.4%	10.4%	22.0%	22.0%	29.1%	268	3.37
Official recommendation	22.4%	12.0%	19.3%	20.8%	25.5%	259	3.15
Businesses closing	34.3%	21.3%	20.1%	11.8%	12.6%	254	2.47
Friends, relatives, coworkers leaving	33.1%	18.1%	18.5%	15.4%	15.0%	260	2.61

Table 5.13: Reasons for Evacuation Decision

Another question which has some bearing on decisions to evacuate is the one in which survey respondents were asked to rate the extent to which they were concerned about four issues: protecting their property from looters, protecting their property from the storm, losing their jobs if they failed to show up at work, and getting caught by the storm while stuck in traffic on the evacuation route. Table 5.14 shows the data on this question. The rankings range from 1 for "not at all" to 5 for "very great extent."

Protecting property from looters was not a major concern for a majority of respondents, but many were concerned about it. Protecting property from the storm was of greater concern overall. Most people were not at all concerned about losing their jobs. Based on the interviews with officials in the Brownsville area, we checked to see if those who did demonstrate some concern were located in the Lower Valley area. Residents of Cameron

County were no more likely to fear for their jobs than residents of other counties (Chi-Square 7.78, not significant).

Concern	1	2	3	4	5	N	Mean
Protect property from looters	32.8%	17.9%	14.2%	10.8%	24.3%	268	2.76
Protect property from storm	6.2%	4.7%	11.3%	21.1%	56.7%	275	4.17
Losing job	83.0%	4.5%	5.7%	3.0%	3.8%	264	1.40
Getting caught in traffic	35.9%	9.3%	13.0%	13.3%	28.5%	270	2.89

Table 5.14: Public Concerns

Since most of the problems with traffic were on the evacuation routes for Corpus Christi, we checked to see if residents of Nueces County were more likely to be concerned about getting caught by the storm while stuck in traffic on the road. The data give some support to this possibility. Nueces County residents ranked concern about traffic either a 4 or a 5 in 58 out of 111 cases, gave it a ranking of 3 in 16 cases, and 1 or 2 in 37 cases (Chi-Square = 25.52, significant at the .10 level). It is possible that the responses were colored by the congestion that did in fact occur during the evacuation. If the concern about getting caught on the road by the storm translates into earlier evacuation during the next event, it will be helpful.

Finally, the decision to evacuate was correlated with the concerns and considerations from Tables 5.13 and 5.14. The results are shown in Table 5.15 (located at the end of this chapter). The variables included in the correlation matrix are: seeing storm related conditions (SCOND); being aware of their own proximity to the coast (PROXC); hearing an announcement of a hurricane watch or warning (HURRW); hearing local authorities issue official recommendations to evacuate (OFFREC); seeing area businesses close (BCLOSE); seeing friends, relatives, neighbors, or coworkers evacuating (FLEAVE); protecting their property from looters (PLOOT); protecting their property from the storm (PSTORM); losing their jobs if they failed to show up at work (LJOB); getting caught by the storm while stuck in traffic on the evacuation route (CTRAFF); and evacuation (EVAC). Seven of the independent variables are significantly and positively correlated with EVAC at the .05 level or better: SCOND, PROXC, HURRW, OFFREC, BCLOSE, FLEAVE, and CTRAFF. The correlations are not strong, however; they range from .1425 (SCOND) to .2827 (PROXC). These data indicate that people are most likely to evacuate when they are aware of the storm conditions and their own proximity to the

coast, have heard a hurricane watch or warning, have received an official recommendation to evacuate, have seen local businesses closing and their friends and families leaving, and are concerned about getting caught by the storm while stuck in traffic. All of these are factors that are consistent with findings from previous research (Baker 1991, Drabek 1986, Lindell and Perry 1992).

• Effects of Income Level

When considering evacuation decisions by the public, it is important to assess the effects of income. The expenses associated with providing transportation, food and lodging may be prohibitive for some people. Although shelters are available for those who need them, transportation is not always provided. In addition, evacuation can mean loss of income through missing work for some time. Table 5.16 shows the frequency of evacuation by income level. There are five categories for this variable; less than $15,000, from $15,000 to $24,999, from $25,000 to 34,999, from $35,000 to 49,999, and more than $50,000. Although fewer low-income respondents evacuated than did not, the same is true for the highest income category. There is only a slight statistically significant difference between the income groups on the decision to evacuate (Chi-square 9.35, significant at the .10 level). The data are suggestive, but far from conclusive at this point.

Income level	< $15,000	$15,000 - $24,999	$25.000 - 34,999	$35,000 - 49,999	> $50,000	Total
N	38	32	38	44	97	250
% that evacuated	18.4	21.9	42.1	15.9	24.7	24.4

Table 5.16: Evacuation by Income

To check further on any role income level may have played in the decision to evacuate, Table 5.17 shows the frequency with which different forms of transportation were used. There were so few people using methods of evacuation other than their own vehicle that no meaningful conclusions can be drawn about the relationship between income and mode of evacuation. There were 82 responses to this question.

Method of Transportation	%
Own vehicle	87.8
Got a ride	7.3
Public transportation	1.2
Other	3.7

Table 5.17: Mode of Transportation

Table 5.18 shows the frequency with which people stayed in hotels or motels, the houses of a friend or relative, public shelters and other accommodations. There were 79 responses to this question.

Where stayed	%
Hotel/motel	26.6
Friend/relative	62.0
Public shelter	2.5
Other	8.9

Table 5.18: Where evacuees stayed

Homes of friends and relatives are by far the most common location mentioned, by 62% of those responding. Motels and hotels are next with 26.6% of the responses, while other with 8.9%, and public shelters with 2.5%, are mentioned much less often. This is consistent with reports from other evacuations where 5-15 % of evacuees stay in public shelter and most stay with friends and relatives (Lindell and Perry 1992). The only people who did report staying in a public shelter reported incomes of under $15,000, but people reporting incomes of more than $50,000 were still more likely to stay with friends or relatives than in hotels or motels by a margin of 16 to 9. Shelter capacity was certainly not strained in Hurricane Bret, and these data suggest it is unlikely to be strained by most events.

• **Problems**

Respondents were asked whether they encountered any of the following problems during their evacuation: traffic jams, shortage of gas, lack of rest stops, lack of food and water, or lack of clear signage. The results are shown in Table 5.19.

Problem	% Reporting	N
Traffic jams	44.2%	77
Shortage of gas	5.7%	70
Lack of rest stops	10.1%	69
Lack of food and water	10.1%	69
Lack of clear signage	1.6%	67

Table 5.19: Evacuation Problems

Few problems were reported overall. More reported traffic jams than any other problem, and were reported only by respondents from Nueces and Kleberg counties, with 26 and 8 positive responses, respectively. A much smaller proportion of the population in the Lower Valley evacuated, so there were no serious traffic problems reported there.

The behavioral survey suggests several recommendations:

5.1. Local governments located on the barrier islands should continue their policies of encouraging total evacuation. They should be supported in these efforts by DEM.

5.2. Public information efforts have not yet reached the entire population, as indicated by the percent of respondents who said they had received information on hurricanes. DEM and local emergency managers should continue to distribute information at all possible opportunities. Spanish-language materials should be used where necessary. The possibility of forming partnerships with local businesses should be studied as a means to disseminate information.

5.3. Corpus Christi officials should continue to study the unique evacuation problems they face. The unfortunate side effect of a near miss like Bret could be to desensitize the population to the potential for danger. DEM should consult with Corpus Christi on evacuation clearance times, which may need to be readjusted to reflect changing settlement patterns, and local officials should be alert to the fact that an evacuation request needs to be issued well before predicted landfall in order to minimize traffic congestion.

5.4. Alternate evacuation routes should be well-publicized and marked at each major intersection. Traffic management authorities should monitor the progress of the evacuation and provide the news media with information on alternate routes that are less congested.

5.5. Specific populations or individuals may need alternate means of transportation in order to evacuate. Local emergency managers should examine their communities for such groups or individuals and try to ensure everyone who wants to leave can do so. Private hospitals and nursing homes should be required to demonstrate the viability of their evacuation plans to local emergency managers. DEM and other state agencies should be encouraged to take the lead in developing transportation programs for special needs populations.

	SCOND	PROXC	HURRW	OFFREC	BCLOSE	FLEAVE	PLOOT	PSTORM	LJOB	CTRAFF	EVAC
SCOND	1.00	.6935	.6303	.5007	.3567	.4014	.0950	.2758	.2012	.2969	.1425
		(.0000	(.000)	(.000)	(.000)	(.000)	(.127)	(.000)	(.001)	(.000)	(.022)
PROXC	.6935	1.000	.7526	.5732	.4023	.4289	.1295	.3120	.1754	.2371	.2827
	(.000)		(.000)	(.000)	(.000)	(.000)	(.038)	(.000)	(.005)	(.000)	(.000)
HURRW	.6303	.7526	1.000	.6146	.5084	.5021	.1157	.2843	.1619	.2411	.2098
	(.000)	(.000)		(.000)	(.000)	(.000)	(.063)	(.000)	(.009)	(.000)	(.001)
OFFREC	.5007	.5732	.6146	1.000	.5585	.5697	.0619	.2103	.0856	.2457	.2823
	(.000)	(.000)	(.000)		(.000)	(000)	(.326)	(.001)	(.176)	(.000)	(.000)
BCLOSE	.3567	.4023	.5084	.5585	1.000	.7144	.1239	.1403	.1354	.1248	.1599
	(.000)	(.000)	(.000)	(.000)		(.000)	(.049)	(.026)	(.032)	(.048)	(.011)
FLEAVE	.4014	.4289	.5021	.5697	.7144	1.000	.1273	.1509	.1367	.3258	.2440
	(.000)	(.000)	(000)	(.000)	(.000)		(.041)	(.016)	(.030)	(.000)	(.000)
PLOOT	.0650	.1295	.1157	.0619	.1239	.1273	1.000	.3628	.1410	.2795	.1194
	(.127)	(.038)	(.063)	(.326)	(.049)	(.041)		(.000)	(.022)	(.000)	(.054)
PSTORM	.2758	.3120	.2843	.2103	.1403	.1509	.3628	1.000	.1544	.1418	.0074
	(.000)	(.000)	(.000)	(.001)	(.026)	(.016)	(.000)		(.012)	(.021)	(.905)
LJOB	.2012	.1754	.1619	.0856	.1354	.1367	.1410	.1544	1.000	.1971	.0041
	(.001)	(.005)	(.009)	(.176)	(.032)	(.030)	(.022)	(.012)		(.001)	(.948)
CTRAFF	.2969	.2731	.2411	.2457	.1248	.3258	.2795	.1418	.1971	1.000	.1943
	(.000)	(.000)	(.000)	(.000)	(.048)	(.000)	(.000)	(.021)	(.001)		(.002)
EVAC	.1425	.2827	.2098	.2823	.1599	.2440	.1194	.0074	.0041	.1943	1.000
	(.022)	(.000)	(.001)	(.000)	(.011)	(.000)	(.054)	(.905)	(.948)	(.002)	

Table 5.15: Correlations of Evacuation with Considerations and Concerns

[1] A copy of the questionnaire is included in the Appendix.

Appendix A

List of Participants in Interviews

NAME	ORGANIZATION
Al Castillo	Marshal High School, San Antonio
Andrew LaFavers	Channel 10 Corpus Christi
Arlene Marshall	Calhoun County Judge
Ben Reyna	Brownsville Police Dept.
Bert Perez	Corpus Christi Public Works
Billy Zwerschke	Calhoun County EMC
Bob Blackwell	TXDOT Corpus Christi
Bob Gibson	DEM
Butch Smith	DEM
Carl Mixon	Bexar County EMC
Carlos Solis	TXDOT Pharr District
Chano Falcon	TXDOT Pharr District
Charlie Montgomery	Hidalgo County EMC
Chris Lawrence	Nueces County EMC
Chuck Garris	Atascosa County EMC
Clifford Rowell	South Padre Island
Dale Nelson	Channel 6 Corpus Christi
Dan Stacks	TXDOT Corpus Christi
David Forrest	Willacy County State Jail
Debbie Skelton	TXDOT Pharr District
Deborah Herber	Atascosa County Judge
Desi Najera	Cameron County EMC
Diana Maldonado	Channel 4 Harlingen
Don Rogers	DEM
Eddie Chapa	Willacy County EMC
Frank Cantu	DEM
Fred Wasielewski	San Benito
Gonzales Benavides	Brook County EMC
Hector Ramos, Sr.	DPS McAllen
Hershel Price	Brownsville Police Dept.
Honoré Castro	Fire Marshall/EMC Hidalgo Co, McAllen
Ismael Soto	TXDOT Corpus Christi
Jack Colley	DEM
James Terrell	OW Holmes High School, San Antonio

Janice Evans	KTRH Houston
Jeff Marton	Texas Department of Criminal Justice
Jesús S. Leal	TXDOT Pharr District
Jim Todd	Red Cross
Joe Hamilton	DPS San Antonio
Joe Tafalla	San Antonio ISD
John Galvan	DPS Corpus Christi
John Park	Trinity Baptist Church, San Antonio
Juan Ortiz	Corpus Christi EMC
Katy Ford	Red Cross
Larry Spence	Willacy County Sheriff
LeRoy Moody	San Patricio County Sheriff
Leslie Harkins	Refugio County EMC
Luis Piñeda	Univision Channel 28 Corpus Christi
Marisol Morales	Salvation Army
Mary Jane Spivey	San Antonio Office of Emergency Management
Michael Huckabee	Red Cross
Mike Peacock	DEM
Miriam Martinez	Univision Channel 48 McAllen
Nancy Bass	Salvation Army
Peter Alvarez	Corpus Christi Police Department
Phil Sokolov	Channel 10 Corpus Christi
Randy Sijansky	DEM
Rey Llanes	TXDOT Pharr District
Rick McLester	Aransas County EMC
Robert Bookout	Victoria Independent School District
Robert Knox	Red Cross
Robert Wood	Texas State Radio Network
Roberto Garcia	Port Isabel
Sharon Moore	Hanna High School Edinburg
Shawn Snider	EMC/Fire Chief, Edinburg
Sherriff Cuellar	Kenedy County Sheriff
Thomas Sanchez	Kleberg County EMC
Tom Brooks	Port Aransas EMC
Tom Millwee	DEM
Wallace "Skip" Kirby	San Patricio County EMC

Interview Team

Carla Prater, Dennis Wenger and Kevin Grady. All members of the team are from the Hazard Reduction and Recovery Center at Texas A&M University

Appendix B

SURVEY OF TEXANS' EXPERIENCES IN HURRICANE BRET

HAZARD REDUCTION & RECOVERY CENTER

A United Nations (UNDHA) Collaborative Centre

1. Based on the enclosed Risk Area Map, which area were you living in when Hurricane Bret approached the Texas coast last year? ..... Risk Area ① ② ③ ④ ⑤ None ⑥
(If you answered "None", skip to question 29s.)

2. If you have moved since the hurricane, what was your previous address?_____

_____

_____

3. To what extent did you rely on each of the following sources in deciding how much you were at risk from Hurricane Bret?	Not at all				Very great extent
a. Local newspapers	①	②	③	④	⑤
b. Local radio stations	①	②	③	④	⑤
c. Local television stations	①	②	③	④	⑤
d. National television (e.g., network news and the Weather Channel)	①	②	③	④	⑤
e. The Internet	①	②	③	④	⑤
f. Friends, relatives, neighbors, and coworkers	①	②	③	④	⑤
f. Local authorities	①	②	③	④	⑤
g. Other (please specify) _____	①	②	③	④	⑤

4. Did you get any of the following types of information from local or state Emergency Management personnel that helped you decide what to do?	No	Yes
a. Risk Area maps	①	②
b. Evacuation route maps	①	②
c. Phone numbers to call for assistance	①	②
d. Checklists of hurricane survival tips	①	②
e Other (please specify) _____	①	②

5. To what extent was the information you received...	Not at all				Very great extent
a. specific about the threat and appropriate protective actions?	①	②	③	④	⑤
b. consistent so that the risk information explained why protective action was needed?	①	②	③	④	⑤
c. clear enough for you to understand what to do and how to do it?	①	②	③	④	⑤
d. complete enough so that you had all the information you needed?	①	②	③	④	⑤
e. contained only information that was relevant to hurricane hazards?	①	②	③	④	⑤

6. Was there any information you needed, but did not receive?_____

_____

_____

7. Just before the storm made landfall, to what extent did you believe that it was...	Not at all				Very great extent
a. likely to strike your community?	①	②	③	④	⑤
b. severe enough to damage your home?	①	②	③	④	⑤

8. To what extent were you concerned about...	Not at all				Very great extent
a. protecting your property from looters?	①	②	③	④	⑤
b. protecting your property from the storm?	①	②	③	④	⑤
c. losing your job if you didn't show up at work?	①	②	③	④	⑤
d. getting caught on the road in the storm during traffic jams on evacuation routes?	①	②	③	④	⑤

9. To what extent were you concerned about having difficulty getting a...	Not at all				Very great extent
a. means of transportation out of the Risk Area?	①	②	③	④	⑤
b. safe route of travel?	①	②	③	④	⑤
c. safe place to stay?	①	②	③	④	⑤
d. place that would take pets?	①	②	③	④	⑤

10. To what extent did the following considerations affect your decision whether or not to evacuate?	Not at all				Very great extent
a. Seeing storm related conditions (such as high winds, rain or flooding)	①	②	③	④	⑤
b. Being aware of my close proximity to the coast	①	②	③	④	⑤
c. Hearing an announcement of a hurricane "watch" or "warning"	①	②	③	④	⑤
d. Hearing local authorities issue official recommendations to evacuate	①	②	③	④	⑤
e. Seeing area businesses closing	①	②	③	④	⑤
f. Seeing friends, relatives, neighbors, or coworkers evacuating	①	②	③	④	⑤

11. Compared to other buildings in your Risk Area, how vulnerable to hurricane damage did you think was your...	Much less than average				Much more than average
a. home	①	②	③	④	⑤
b. workplace	①	②	③	④	⑤

12. Which of the following steps did you take *before Hurricane Bret made landfall* to protect your home from the hurricane?	No	Yes
a. Protected windows shutters, plywood, or tape	①	②
b. Reinforced doors to the house and garage	①	②
c. Secured and removed loose objects from the yard	①	②
d. Moved boats, campers, etc.	①	②
e. Elevated furniture, appliances, rugs, etc above potential flood levels	①	②
f. Sandbagged around the property	①	②
g. Purchased items for making repairs during and after the storm	①	②
h. Bought/rented an electric generator	①	②
i. Tied down plants	①	②
j. Cut off dangerous tree limbs	①	②
k. Other (please specify) _____	①	②

13. Did you evacuate? ① No ② Yes
(If you did evacuate, go to question 15.)

14. *If you did not evacuate,* what steps did you take to protect yourself and your family during the hurricane?	No	Yes
a. Sheltered in an interior windowless room	①	②
b. Covered up with pillows or blankets	①	②
c. Nothing	①	②
d. Other (please specify) _____	①	②

(If you did not evacuate, go to question 29.)

15. When did you decide to evacuate? Day _____ Time _____

16. After you decided to evacuate, how many *minutes* did it take for you to:

(skip to item "c" if you were not at work)	less	30	45	60	more
a. Prepare to leave from work?	①	②	③	④	⑤
b. Travel from your place of work to your home?	①	②	③	④	⑤
c. Gather all of the persons who would evacuate with you?	①	②	③	④	⑤
d. Pack the items you would need while gone?	①	②	③	④	⑤
e. Take steps to protect your property from storm damage (e.g., board up windows)?	①	②	③	④	⑤
f. Shut off utilities, secure your home, and leave?	①	②	③	④	⑤

17. When did you actually leave?..... Day _____ Time _____

18. What form of transportation did you use to evacuate? (check one)
   a. Took my own private vehicle..... ① **a**
   b. Got a ride with someone else..... ② **b**
   c. Used public transportation..... ③ **c**
   d. Other (please specify)_____..... ④ **d**

   (If you answered "b", "c", or "d", go to question 21)

19. How many vehicles did your household take with you in the evacuation? ..... _____ **vehicles**

20. How many trailers (including boats & campers) did your household take with you in the evacuation? ..... _____ **trailers**

21. Did the number of vehicles you took include a motor home or recreational vehicle? ..... ① **No** ② **Yes**

22. What evacuation route did you use? _____

23. Why did you choose this route? (check one)
   a. It was on maps I received before the hurricane ..... ① **a**
   b. It was recommended by the news media during the event..... ② **b**
   c. It was recommended by local officials during the event ..... ③ **c**
   d. It seemed to be the most logical route at the time ..... ④ **d**
   e. Other (please specify) _____ ..... ⑤ **e**

24. Did you encounter any of the following problems while evacuating, such as	No	Yes
a. traffic jams?.....	①	②
b. shortages of gas?	①	②
c. lack of rest stops?.....	①	②
d. lack of food and water?	①	②
e. lack of clear signage?.....	①	②

25. What city was your final destination when you evacuated? _____

26. Where did you stay when you got there? ___①___ **Hotel/motel** ___②___ **Home of friend/relative** ___③___ **Public shelter** ___④___ **Other**

27. During your evacuation, how many days did you spend away from home? _____

28. How much money did it cost for your household to evacuate (e.g., gas, food, lodging)? _____

29. Do you have any of the following in the place where you live?	No	Yes, had *before* Bret	Yes, had *after* Bret
a. a working transistor radio with spare batteries	①	②	③
b. at least 4 gallons of water in plastic containers	①	②	③
c. a complete first-aid kit	①	②	③
d. a 4 day supply of dehydrated or canned food for yourself and your family	①	②	③
e. a fire extinguisher	①	②	③
f. wrenches to operate utility shutoff valves and switches	①	②	③

30. Have you done any of the following for the place where you live?	No	Yes, did *before* Bret	Yes, did *after* Bret
a. purchased plywood, plastic film, or shutters or to protect windows in a hurricane	①	②	③
b. purchased lumber to brace house and garage doors in a hurricane	①	②	③
c. reinforced roof rafters or gable ends against high winds	①	②	③
d. attached the roof to walls using hurricane straps	①	②	③
e developed a household hurricane emergency plan	①	②	③
f. purchased flood insurance	①	②	③
g. contacted the Red Cross or government agencies for information about hurricane hazard	①	②	③
h. attended meetings to learn about hurricane hazard	①	②	③
i. joined a community organization dealing with hurricane preparedness	①	②	③

31. To what extent do you expect your personal safety in a future hurricane will be determined by the actions of...	Not at all				Very great extent
a. yourself and your immediate family?	①	②	③	④	⑤
b. friends, relatives, neighbors or coworkers?	①	②	③	④	⑤
c. local newsmedia?	①	②	③	④	⑤
d. local government?	①	②	③	④	⑤
e. state or federal government agencies?	①	②	③	④	⑤
f. luck or chance?	①	②	③	④	⑤
g. God's will?	①	②	③	④	⑤

32. How old are you? _____ **years old**

33. What is your sex? ___①___ **Male** ___②___ **Female**

34. To which of the following ethnic groups do you belong and identify?
___①___ **Hispanic**
___②___ **Asian/Pacific Islander** ___③___ **African American** ___④___ **Caucasian**
___⑤___ **Native American** ___⑥___ **Mixed** ___⑦___ **Other**

35. What is your marital status? ___①___ **Married** ___②___ **Single**
___③___ **Divorced** ___④___ **Widowed**

36. What is your highest level of education? __①__ **Less than high school** __②__ **High school**
__③__ **Some college/vocational school** __④__ **College graduate** __⑤__ **Graduate school**

37. What is your *yearly* household income? ___①___ **Less than $15,000** ___②___ **$15,000–24,999**
___③___ **$25,000–34,999** ___④___ **$35,000–49,999** ___⑤___ **More than $50,000**

38. Do you own or rent the home where you now live? ___①___ **Rent** ___②___ **Own**

39. What is the estimated amount of damage to your house and belongings from Hurricane Bret? $_____

40. About how much of the damage did your insurance cover? $_____

41. What type of structure is your home? ___①___ **House** ___②___ **Mobile home**
___③___ **Apartment** ___④___ **Other**

42. How many years have you lived in the home where you now live? _____ **years**

43. How many years have you lived in the coastal area of Texas? _____ **years**

44. How many people live in your household? _____ **persons**

45. In your household, are there...	No	Yes
a. children under the age of 18?	①	②
b. adults over the age of 65?	①	②

46. Is any of the following statements true about your experience with Hurricane Bret?	No	Yes
a. Your immediate family's property was damaged in the hurricane	①	②
b. You or an immediate family member was been injured in the hurricane	①	②
c. Property of a friend, relative, neighbor, or coworker you know personally was damaged in the hurricane	①	②
d. A friend, relative, neighbor, or coworker you know personally was injured in the hurricane	①	②

Do you have any comments about your experience during Hurricane Bret?

_____
_____
_____
_____
_____
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_____
_____
_____
_____
_____

This concludes the survey. Please return this page in the envelope provided. ***Thank You.***

Appendix C

Preliminary Best Track for Hurricane Bret
Source: National Hurricane Center Preliminary Report

Date/Time UTC	Lat. (°N)	Lon. (°W)	Pressure (mb)	Wind Speed (kt)	Stage
18/1800	19.5	94.4	1010	30	Tropical depression
19/0000	19.5	94.5	1008	30	"
0600	19.6	94.6	1008	30	"
1200	19.7	94.6	1008	30	"
1800	19.8	94.7	1005	35	Tropical storm
20/0000	19.8	94.7	1000	40	"
0600	20.0	94.6	998	45	"
1200	20.4	94.5	993	50	"
1800	21.2	94.4	991	55	"
21/0000	21.9	94.5	983	65	Hurricane
0600	22.5	94.7	980	75	"
1200	23.1	94.9	979	80	"
1800	23.8	95.0	975	90	"
22/0000	24.7	95.1	954	120	"
0600	25.5	95.5	950	125	"
1200	26.2	96.1	944	125	"
1800	26.6	96.8	946	120	"
23/0000	26.9	97.4	951	100	"
0600	27.0	97.9	963	80	"
1200	26.9	97.4	951	60	Tropical storm
1800	27.6	98.8	993	35	"
24/0000	28.0	99.5	1000	30	Tropical depression
0600	28.0	100.4	1003	30	"
1200	27.8	101.3	1006	25	"
1800	27.7	102.1	1007	25	"
25/0000	27.6	103.0	1008	20	"
0600					Dissipated
22/1200	26.2	96.1	944	125	Minimum pressure
23/0000	26.9	97.4	951	100	Landfall at central Padre Island, Texas

Appendix D

Watch and Warning Summary
Source: National Hurricane Center Preliminary Report

Date/Time (UTC)	Action	Location
19/2100	Tropical Storm Warning issued	Tampico to Coatzacoalcos, Mexico
20/1500	Hurricane Watch and Tropical Storm Warning issued	La Pesca to Veracruz, Mexico
20/1500	Tropical Storm Warning discontinued	Veracruz to Coatzacoalcos, Mexico
21/0900	Hurricane Watch issued	Tuxpan, Mexico to Baffin Bay, Texas
21/0900	Hurricane Watch and Tropical Storm Warning discontinued	Tuxpan to Veracruz, Mexico
21/1500	Hurricane Warning issued	La Pesca, Mexico to Baffin Bay, Texas
21/2100	Hurricane Watch and Tropical Storm Warning issued	Baffin Bay to Port Aransas, Texas
22/0300	Hurricane Warning issued	Baffin Bay to Port O'Connor, Texas
22/0300	Hurricane Watch and Tropical Storm Warning issued	Port O'Connor to Freeport, Texas
22/0900	Hurricane Watch discontinued	Tuxpan to Tampico, Mexico
22/1500	Hurricane Watch discontinued	Tampico to La Pesca, Mexico
22/2100	Hurricane Watch discontinued	Port O'Connor to Freeport, Texas
23/0100	Hurricane Warning discontinued	La Pesca to U.S./Mexican border
23/0300	Hurricane Warning downgraded to Tropical Storm Warning	north of Port Aransas to Port O'Connor, Texas
23/0300	Tropical Storm Warning discontinued	north of Port O'Connor to Freeport, Texas
23/0900	Hurricane Warning downgraded to Tropical Storm Warning	Brownsville to Port Aransas, Texas
23/2100	Tropical Storm Warning discontinued	Brownsville to Port Aransas, Texas

Appendix E

Observed Storm Tides
Source: National Hurricane Center Preliminary Report

Location	Storm Surge (ft)	Storm Tide (ft)
Port Isabel	1.1	
Bob Hall Pier		2.6
Rockport ASOS		1.8
Freeport		2.4

Appendix F

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